SCIENCE

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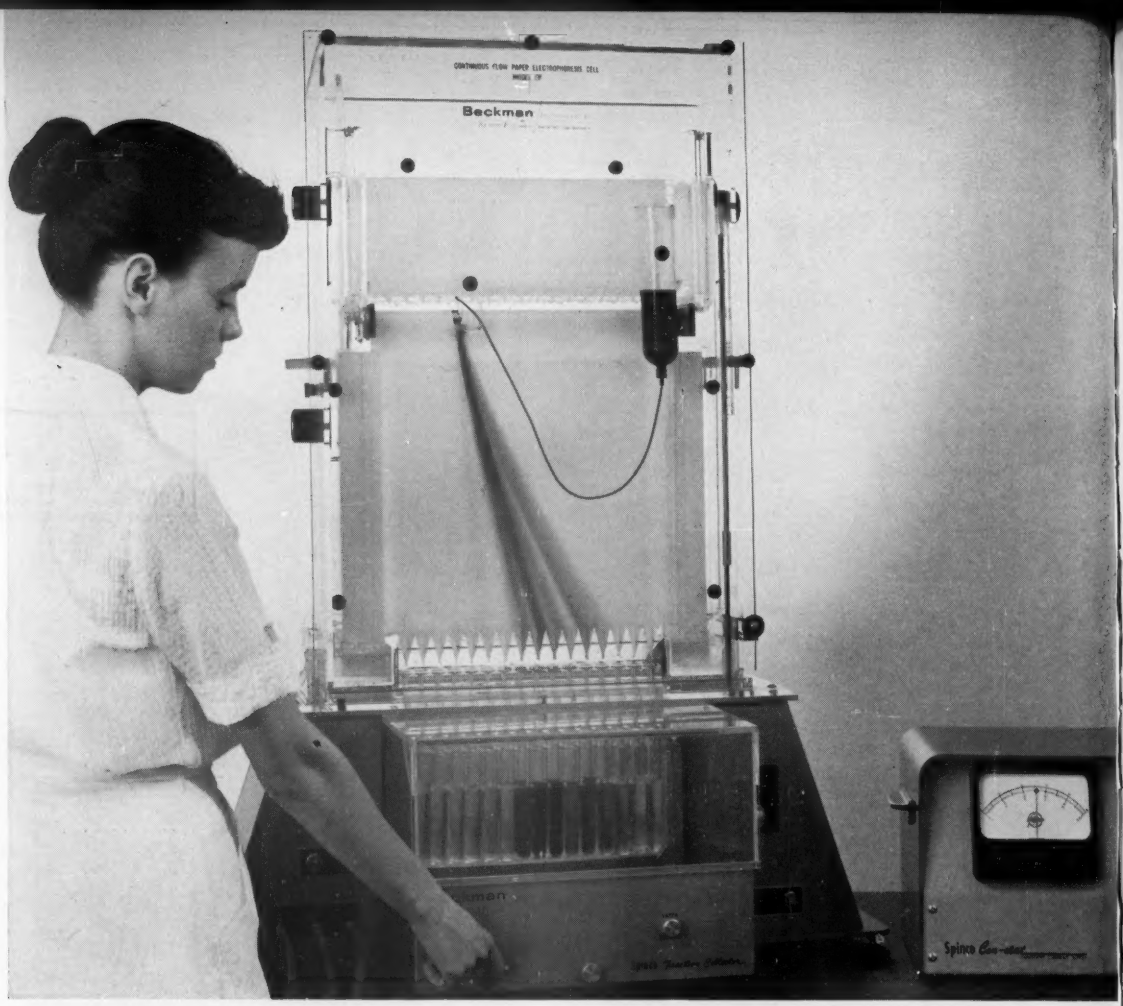

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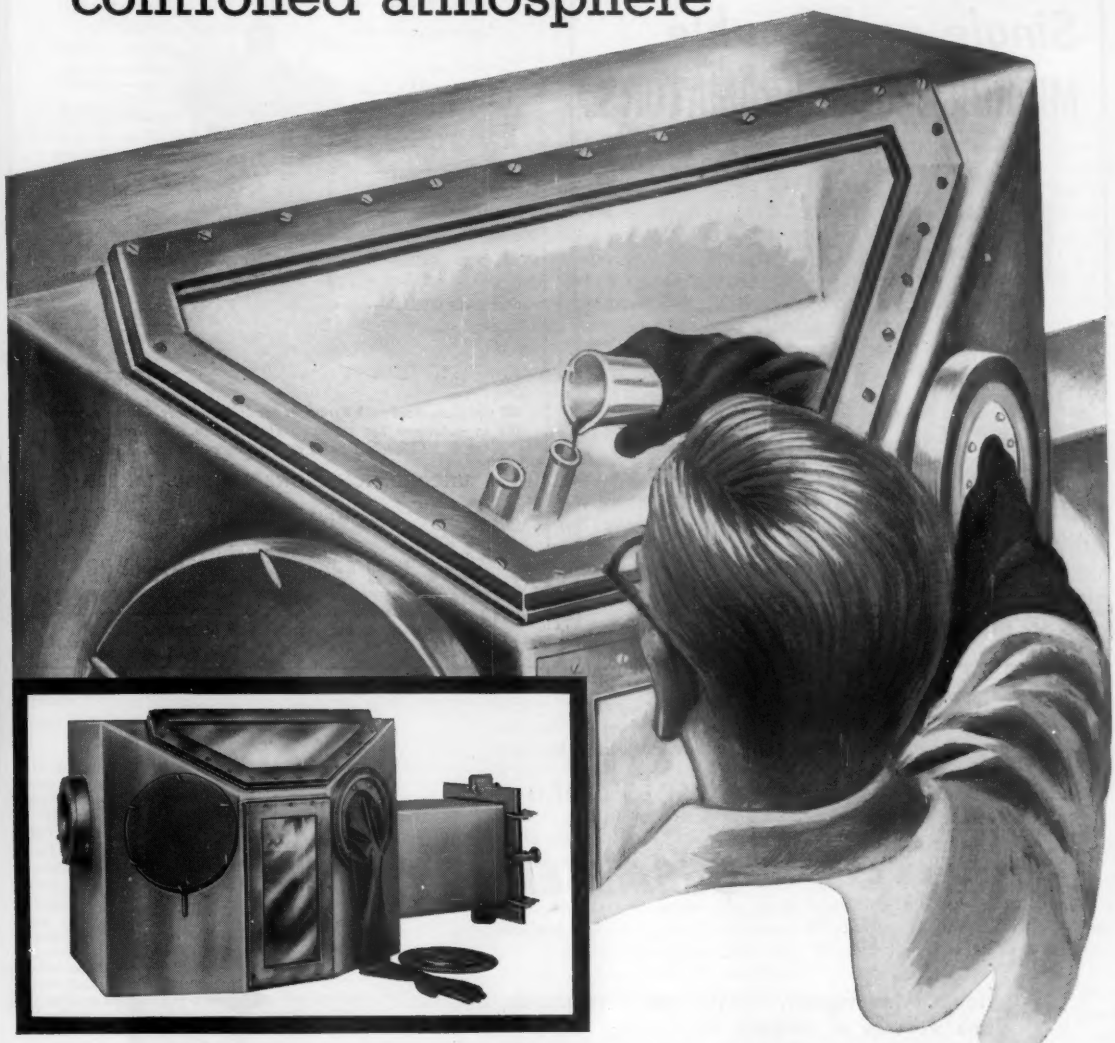

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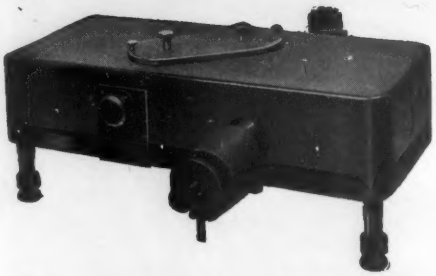

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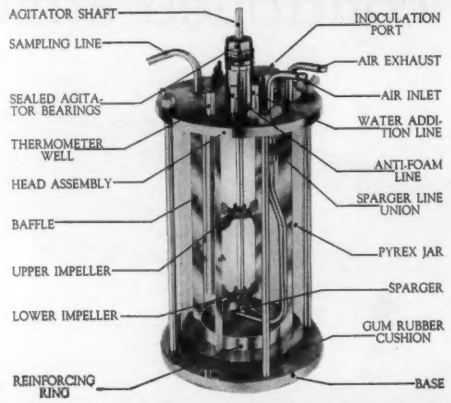

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Costs of Higher Education

During the last decade the cost of a college education has increased sharply. A recent survey by the *New York Times* of 35 representative public and private colleges and universities showed that tuition increases ranged from 50 to more than 100 percent in the period from 1946–47 to 1956–57.

Although spokesmen for some of the institutions in the survey thought that scholarship aid would keep pace with the rise in costs, spokesmen for others were not so hopeful. An important and socially undesirable consequence of the tuition increases, insofar as they are not met by additional scholarship aid, will be to bar some well-qualified students from higher education on purely economic grounds. This is, of course, not new. Some promising students have always been prevented from going to college by lack of money. But, if it is not new, it is intensified, and further rapid increases may deter a proportionally larger number of students.

How great is the loss of potential college students? Charles C. Cole, Jr., assistant dean of Columbia College, attempted to answer this question last autumn in a study carried out for the College Entrance Examination Board under a grant from the National Science Foundation. Cole estimated that some 200,000 high-school students who were in the upper 30 percent of their senior classes last autumn failed to go on to college; some 700,000, many of whom were not as well qualified, did go. The loss is substantial, but it can be attributed only in part to lack of funds. Of the 200,000 Cole showed that about 50,000 had considerable potential scientific ability, and he concluded that between 8000 and 15,000 male high-school students of this group "could be retrieved if they could be found and provided with sufficient financial aid to enable them to go to college."

That the states should make some contribution to education has long been recognized, as is shown by tax exemptions granted to private colleges and universities and by state support of public institutions. The Federal Government has a long record of support of education from the Morrill Act in 1862, which made possible the land-grant colleges, to recent grants for research and training.

Thus, partial support of the institutions of higher education is a well-established function of both state and federal government. The direct support of students is more recent and more fragmentary. A few states, California and New York among them, have extensive scholarship programs. The Federal Government has, aside from financial aid during the depression and scholarships to veterans of World War II and the Korean War, held aloof. The numerous scholarship bills introduced at each recent session of Congress have died in committee.

It is a hopeful sign that private and industrial donations, both for operating expenses and scholarships, are increasing and that a National Merit Scholarship Program has been launched with support from the Fund for the Advancement of Education and from industrial donors. The proposal by Paul E. Klopsteg of a tax adjustment that would greatly encourage private and industrial gifts to education is attracting widespread interest [*Science* **124**, 965 (1956)]. In addition, for those who have some financial resources, the pay-as-you-go plan for tuition and board and room is helpful. An increasing number of colleges and universities are entering contracts with a New York corporation, Tuition Plan, Inc. Tuition Plan pays the institutional fees in a lump sum in September and January and bills parents monthly. The only cost is a 4-percent carrying charge to the parents. This plan of installment payments for education has caught on rapidly: in 1955, contracts totaled $8.7 million; in 1956, $12 million; in 1957, $30 million; in 1958, an estimated $100 million.

It is too early to tell what final balance between public and private support will be worked out, but the vigorous discussion and numerous plans give grounds for the hope that some way will be found to see to it that no qualified person fails to attend college for financial reasons.—G. DuS.

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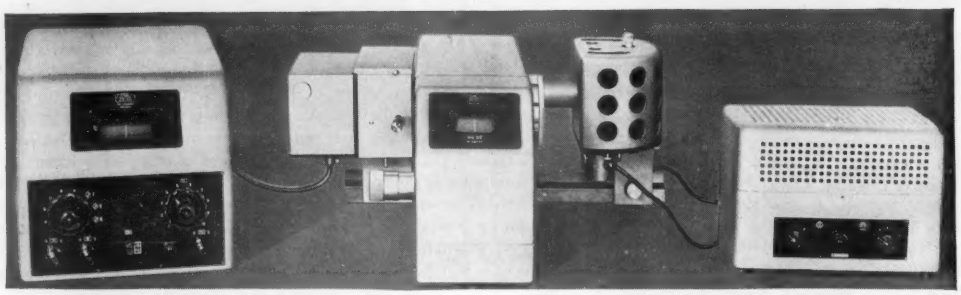

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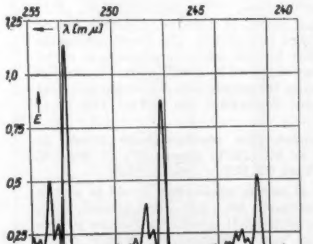

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National Science Foundation: the First Six Years

Dael Wolfle

The National Science Foundation is authority for the information that 38 agencies of the Federal Government conduct scientific activities (*1*). In 36 of these agencies, the scientific work is organized about practical problems—agriculture, aviation, medicine, meteorology, or some other applied interest. The two exceptions are the National Science Foundation and the Smithsonian Institution; their focus is science itself. Other agencies support fundamental research, but only as underlying support for their more primary responsibilities. In contrast, the National Science Foundation has as its responsibility the advancement of science, in all its branches and regardless of its applications.

Depending upon the event one selects as marking the birth date, the foundation is only 6 or 7 years old. It was 10 May 1950 when President Truman signed the National Science Foundation Act of 1950; 6 April 1951 when Alan T. Waterman was sworn in as the first director; and September of 1951 when Congress voted the first operating funds to the foundation (*2*).

In those few years the foundation has shown such a lusty growth that a review of its development and an appraisal of its activities are timely.

Functions

The powers and responsibilities assigned to the foundation by Congress (*3*) are as follows: "To develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences; to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering, and other sciences . . . ; to award . . . scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences; to foster the interchange of scientific information among scientists in the United States and foreign countries; to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups; to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States, including its Territories and possessions."

Administrative Structure

To carry out these responsibilities, Congress created a peculiar, two-headed structure. One head is the director; the other is the National Science Board. Both are appointed by, and both are responsible to, the President. The wording of the Act makes it clear that Congress intended neither to be a figurehead, for important responsibilities were assigned to each. The director is the chief executive officer of the foundation, and certain powers and duties are designated as his. The board can delegate additional powers and duties to him, but some responsibilities cannot be delegated. The director (with the help of his staff) selects the recipients of fellowships and scholarships and of grants and contracts in support of research. But final action on these matters must, in all cases, be taken by the board. Responsibility for establishing policy is clearly assigned to the board and cannot be delegated, even to the board's executive committee.

This structure represents a compromise between two opposed ideas of appropriate organization that were debated all through the legislative history of the National Science Foundation Act. One group of supporters thought the foundation should be headed by a Presidentially appointed board of 48 (later reduced to 24) distinguished representatives of the fields of science, education, and public affairs. This board was to be empowered to select the director of the foundation. The director, under this arrangement, would have been responsible to the board rather than to the President. Advocates of this structure hoped that a large board would insure wide representation of the views of scientific leaders, expected that the responsibility of membership would make appointment attractive to men of high competence, and believed that this administrative structure would guarantee against the appointment of the foundation's director on political grounds.

In contrast, other supporters of a science foundation—including, apparently, a majority of scientists (*4*)—thought the director should be appointed by, and should be directly responsible to, the President. To advise the director and his staff, advocates of this administrative structure recommended the appointment of an advisory board, smaller in size than the supervisory board called for by adherents of the other school of thought. Advocates of this structure pointed out that such an arrangement was in better agreement with usual ideas of good governmental administration and argued that a large board would so diffuse responsibility that no one could be held responsible for the success or failure of the organization.

This issue was more vigorously debated than any other aspect of the foundation idea. Yet once the bill became law, the argument quickly died. It is impossible to say how well an alternative type of organization would have worked, but Chester Barnard, former chairman of the National Science Board, wrote in the foundation's *Fifth Annual*

The author is executive officer of the AAAS.

Table 1. Annual appropriations and Presidential recommendations of funds for the National Science Foundation.

Fiscal year	Appropriation	President's recommendation
1951	$ 225,000	$ 475,000
1952	3,500,000	14,000,000
1953	4,750,000	15,000,000
1954	8,000,000	15,000,000
1955	12,250,000	14,000,000
1956	16,000,000	20,000,000
1957	40,000,000	41,300,000
1958	40,000,000	65,000,000

Report: "During the five years of its work, this peculiar organization, depending upon cooperation between the Board and the director, has worked exceedingly well." The absence of any attempt to change the administrative structure is a testimonial to both the board and the director, for good cooperation has been essential and has apparently been achieved.

Reputation

There are both favorable and unfavorable attitudes toward the foundation. As a slightly oversimplified distinction, the foundation has been applauded for what it has done and criticized for what it has not done. On the one hand, the foundation readily accepted responsibility for and quickly earned an excellent reputation for the manner in which it carried out its clearly assigned functions of making research grants, awarding fellowships, and in other ways giving direct, substantive support to research. On the other hand, the Congressional instructions to establish national science policy are subject to varying interpretations; the foundation has been more deliberate about accepting this responsibility, and what it has done has frequently not come to public notice. Thus, the bulk of the criticism has been leveled against what the critics consider the foundation's failure to take a sufficiently dominant position in the establishment of policy. In short, the foundation has been approved for carrying out its more clearly defined responsibilities and criticized for slowness and lack of aggressiveness in carrying out its less clearly defined responsibilities.

After a brief review of the growth of the foundation's annual budgets and scale of operations, I will discuss the programs of direct support to basic research. The foundation's operating policies concerning grants, fellowships, and other activities will be discussed in connection with those activities. Other policy questions will be taken up later, in a separate section.

Growth

When the National Science Foundation was first being debated in Congress, no one knew just how large it might grow or how much money it might effectively use. Early legislative proposals therefore followed the customary practice of authorizing Congress to use its own judgment in making annual appropriations. But before the enabling act was actually passed, an economy wave swept through the Federal Government, and one of the compromises that helped to secure passage was a limitation to $15 million on the amount of direct appropriations that Congress could make in any one year. Appropriations for the first few years were well below that ceiling, but in 1953 Congress removed the $15 million limitation.

In accordance with Government practice, appropriations are for fiscal years—that is, the 1956 appropriation was for the period from 1 July 1955 through 30 June 1956. The first appropriation, for fiscal year 1951, was only $225,000, an amount intended solely to allow the foundation to organize. In subsequent years, as shown in Table 1, the appropriations rapidly grew larger.

With some variation from year to year, the history of the annual appropriation has been about as follows: the President recommended a figure somewhat above the appropriation for the previous year; the House of Representatives voted the amount of the previous year's appropriation, and the Senate, approximately all of the President's request; the Senate and the House of Representatives compromised somewhere between the amounts each had voted; thus, the foundation received the increasing appropriations shown in Table 1.

The distribution of the foundation's growing budgets among the principal areas of activity is given in Table 2. The program has expanded in terms of the amount of money devoted to a particular type of support of science, and also by the addition of new types of support that were not feasible on earlier and smaller budgets. Table 3 shows the number of research grants made each year, the number of fellowships awarded, and the number of institutes for science teachers supported, and gives other indications of a growing program.

Research Grants

Grants in support of research constitute the foundation activity that has been of most direct interest to the largest number of scientists and the activity on which, in most years, the foundation has spent the largest amounts of money. The annual amount increased from $1 million in 1952 to $9.5 million in 1956 and, during those 5 years, enabled the foundation to make 1969 research grants, many of them for 2-, 3-, or 5-year terms. The average grant has been slightly above $12,000, for an average duration of 2 years, but some have been ten or

Table 2. Distribution of National Science Foundation expenditures among major activities.

Category	1952	1953	1954	1955	1956	1957 (estimated)
National science policy studies	$ 130,200	$ 207,167	$ 800,121	$ 901,278	$ 679,933	$ 750,000
Research grants in:						
Biological and medical sciences	762,675	830,586	1,971,789	3,611,562	4,793,129	16,125,000
Mathematical, physical, and engineering sciences	311,300	982,715	2,032,780	4,397,907	4,698,689	
Grants for support of research facilities:						
Biological and medical sciences					125,000	750,000
Mathematical, physical, and engineering sciences					397,500	5,135,000
Graduate and postdoctoral fellowships	1,532,971	1,366,344	1,865,978	1,783,706	2,131,026	2,500,000
Education in the sciences	7,200	40,844	160,790	315,790	1,434,275	14,000,000
Review of research and training programs		432,022	412,414	677,551	738,165	
Dissemination of scientific information	69,700	158,654	238,300	326,285	510,318	900,000
Attendance at international meetings	17,153	33,565	53,058	77,054	46,043	
Assistance to other federal scientific activities	122,755	23,272			10,000	
Executive direction and management	512,046	355,746	426,301	395,130	503,651	
Total	3,466,000	4,430,915	7,961,531	12,486,263	16,067,729	40,000,000

Table 3. National Science Foundation activities in support of research and education in the sciences.

Category	1952	1953	1954	1955	1956	1957
Number of grants in the biological and medical sciences	68	72	177	275	426	
Number of grants in the mathematical, physical, and engineering sciences	28	100	197	313	308	
Predoctoral fellowships	535	515	657	715	775	845
Postdoctoral fellowships	38	42	79	70	150	239
Institutes for college teachers of science or mathematics	0	2	3	7*	12†	9‡
Institutes for high-school teachers of science or mathematics	0	0	1	6*	18†	90‡
Conferences on special problems and areas	0	8	19	21	29	
Grants for attendance at international meetings outside the U.S.	23	54	101	132	13	

* Two of these institutes were open to both high-school and college teachers. † Five of these institutes were open to both high-school and college teachers. ‡ Four of these institutes were open to both high-school and college teachers.

more times that amount, and others have been much smaller.

The foundation's annual reports list the individual research grants made during the preceding year. The headings under which those grants are classified indicate the scope of the foundation's research support: anthropological and related sciences, astronomy, chemistry, developmental biology, mathematical sciences, molecular biology, physics, psychobiology, regulatory biology, systematic biology, and general.

The inclusion of anthropological and related sciences in this list is the outcome of debate that goes back to the first year in which Congress considered establishing the foundation. It was clear from the beginning that physical and biological sciences would be included, but whether or not to include the social sciences was a major issue. Proponents contended that it was at least as important to advance the social sciences as the other branches of science and that inclusion would aid their development. Opposition was centered on one argument and one type of confusion. The argument ran that the social sciences were not so highly developed as other branches of science and that the ability of social scientists to solve important social problems was to be doubted. The confusion was between research on human problems and the practical control of human affairs. This confusion was illustrated in some of the debate when salesmen, legislators, and other practical manipulators of social affairs were identified as social scientists.

The outcome was a compromise that gave the foundation itself freedom to decide. As early as 1947, some of the bills described the scope of the foundation as the "mathematical, physical, medical, biological, engineering and other sciences." This language, permissive but not mandatory with respect to the social sciences, was included in the enabling act as it was finally approved.

In the course of its own operations, the foundation early became engaged in studies in the social science area: studies of the state of development of individual fields of science, studies of the nation's manpower resources, studies of research trends, and studies of the economics of scientific research (*5*). In 1953 a staff position for social science was established, and the foundation began a systematic and continuing survey of the scientific status of work in the social sciences and of the foundation's role in such work. In 1954 the National Science Board approved recommendations for a limited program of support for social science research.

Policy Issues on Grants

The foundation has considerable freedom to decide for itself how its support should be distributed and what types of grants will most effectively promote scientific progress. Thus, the foundation could make grants for individual projects, or it could make general-purpose grants that do not specify the particular studies to be supported. There is ample precedent for both types. For example, the National Heart Institute reported in 1956 that it had made 650 grants for individual projects, 60 grants in support of broader programs of research, and 12 grants under which the institution being supported was given almost complete freedom to work on any research problem that seemed appropriate. The American Cancer Society makes large grants to selected universities to permit each to endow a research professorship for the life of the incumbent.

The type of grant that it will make is a matter of fundamental operating policy of any foundation, and the National Science Board of necessity had to consider this matter very early in its deliberations. The decision was to support individual projects. It is hard to see how the foundation, with its small early budgets, could have decided otherwise, yet the basis for the decision went well beyond budget limitations. Support of individual projects was the technique followed by the Office of Naval Research, which in some respects was a pattern-maker for the foundation and from which the foundation secured a number of members of its staff, including the director. Moreover, the foundation has from time to time discussed this point with research scientists and has concluded that a majority of them favor grants for individual projects over other types of grants. The foundation's policy was given emphasis in the *Fifth Annual Report*: "Research can be supported by aiding departments or institutions without specification as to the precise nature of the scientific work to be done. However, the Foundation believes that at present it can best aid progress in science and the development of a concerted scientific effort throughout the country by selecting for support those problems in science adjudged most meritorious in the eyes of the country's leading experts in the respective fields."

Along with the advantages of the policy adopted by the foundation there are also disadvantages. The method is in some respects a neutral one, for it merely adds a comparatively small amount of money to a larger amount that is already available, from other sources, for the same purpose and distributes that money in the same way that most of the funds from other sources are distributed. Thus, although the foundation's decision has been made, perhaps it will want to reconsider that decision as its stature and budget increase. For it is an exceedingly interesting question to ask: How soon, or on top of what level of already existing support, or in what stage of development of a field is it desirable to make broad program grants, as distinct from individual project grants?

Assuming that grants are to be made on an individual project basis, the foundation might passively wait for proposals and then make grants in support of those that seem most meritorious, or it might decide, in advance, to concentrate its support in those areas of investigation that seem in greatest need. These alternatives face every research-supporting agency, and the usual decision is to select some areas that the agency decides to emphasize. To some extent the foundation has also followed this course. Initially, as has already been pointed out, it did not support work in the social sciences; later, it announced that selected work in the social sciences would be supported. In some of its annual reports the foundation has announced that it would emphasize certain research areas, for example those related to the International Geophysical Year.

Facilities for Research

In 1955 and 1956 the foundation undertook the systematic study of the national need for scientific installations that were not likely to be provided from other sources. It recommended that the Federal Government assume responsibility for providing large-scale and expensive research facilities when the need is clear and when support is not likely to come from other sources. Although Congress has not approved this recommendation as a statement of general policy, appropriations permitted the foundation to broaden its scope in 1956 by allotting half a million dollars to the construction of research facilities. This small beginning was greatly increased in 1957, when a markedly enlarged budget permitted the allotment of $4 million to the construction of a radio-astronomy installation in West Virginia, $500,000 toward the construction of a nuclear reactor at Massachusetts Institute of Technology, $135,500 toward the construction of computation centers and for research in numerical analysis at five universities, and $750,000 to assist field stations for biological research.

Fellowships

In contrast to its policy with respect to other activities, the foundation began its fellowship program at about the same level that has been maintained during subsequent years. This early emphasis on graduate fellowships was dictated by the growing shortage of research scientists and by the termination of the fellowship program of the Atomic Energy Commission.

The 3200 graduate fellowships that have been awarded have been divided in roughly equal proportions among students who are entering their first year of graduate study, those who have already had one or more years of graduate work, and those who are in their final year of graduate work. The percentage of fellowships awarded to students who are just beginning graduate work has, however, increased somewhat over the years.

The foundation has also awarded 327 postdoctoral fellowships—typically to young scientists. In 1956 a program of senior postdoctoral fellowships was initiated, with 52 awards to mature scientists who gave promise of profiting from a year of research or study free from their usual duties. In 1957 a program of fellowships for teachers of science was started, with 100 grants.

Classified by field of study, the fellowships, at all levels, were distributed as follows during the first 5 years: 28 percent in the life sciences, 23 percent in chemistry, 22 percent in physics and astronomy, 13 percent in engineering, 9 percent in mathematics, and 5 percent in the earth sciences. By geographic region, distribution of these fellowships matched, almost exactly, the distribution of applications and was in close agreement with the geographic distribution of graduate students. The universities attended by the fellowship winners have been much more concentrated geographically, for the highly selected students to whom fellowships were awarded have tended to concentrate in the universities of greatest renown and best scientific facilities.

The foundation has authority to award undergraduate scholarships as well as graduate and postdoctoral fellowships but has not exercised that authority. The decision may not be a permanent one, but thus far the foundation has adopted the farsighted position that it is not in the national interest to offer federal scholarships to undergraduates who wish to become scientists so long as similar support is not available to undergraduates who wish to specialize in other fields.

Fellowship Policy Problems

Prior to World War II, most graduate students in the sciences earned a considerable portion of their expenses by serving as assistants in classroom or laboratory. There were a few fellowships, and there were always a few students whose graduate work was financed in other ways. But an assistantship was the standard method of support, and the number of assistantships largely determined the number of graduate students. After World War II it became desirable to increase the number of scientists, and the Atomic Energy Commission, the National Institutes of Health, the National Science Foundation, and other agencies began offering graduate fellowships in numbers that would have been inconceivable a few years earlier. An increase in the number of graduate students materialized, but perhaps there have also been other results that should be considered. Some faculty members complain that the large number of fellowships makes it difficult to get assistants and that the students who are appointed to assistantships are consequently of lower quality. A few critics have even expressed the wish that first-year graduate fellowships be abolished. The facts of the case are not clearly known, but if the effects are as some people claim, then one cannot help but wonder about such questions as these: What are the educational advantages of a fellowship over an assistantship, and vice versa? Does the alleged lower quality of graduate assistants have an adverse effect on the education and motivation of the undergraduate students who are taught, in part, by these graduate assistants? Is there some pattern for combining the educational values of fellowships and assistantships that would be more desirable that the present system of granting fellowships for all years of graduate training? This is not a nice, neat set of problems that can be solved in a year or two. The problems will be with us for a long time, and they deserve more systematic analysis than they appear to have received. The National Science Foundation alone cannot do this job, but, in cooperation with university and college teachers, it could conduct a study that would be of wide interest to the educational world.

Conferences and Institutes

The foundation has supported a number of research conferences, beginning with eight in 1953 and rising to 29 in 1956. Many of these conferences have crossed disciplinary boundaries, and many have attracted eminent participants from other countries. One was the International Arid Lands Meetings, arranged by the AAAS in 1955. Others have been centered on such diverse topics as anomalous magnetization of rocks, radiocarbon dating, problems of nuclear structure, quantitative biology, Lie groups and Lie algebras, radio astronomy, and problem-solving behavior.

As another contribution to the exchange of scientific information, the foundation has enabled a number of American scientists to attend international meetings held in other countries. After a steady increase (Table 2), the number of travel grants dropped sharply in fiscal year 1956, for in approving the 1956 budget, the House of Representatives refused to authorize funds for foreign travel. A year later Congress reversed its attitude, so this useful service was resumed and is again in full swing.

In 1953 the foundation began to support summer conferences or institutes for college teachers of science. The number of such institutes grew steadily in the following years. A year after the first institutes for college teachers were held, the foundation scheduled a similar institute for high-school teachers. The usefulness of these institutes in providing additional knowledge of science and mathematics to high-school teachers of these subjects was quickly recognized. One such institute, in 1954, was followed by six in 1955, 18 in 1956, and 90 in 1957.

In 1956–57 the foundation tried out the idea of year-long institutes for high-school teachers. Emphasis, as in the summer institutes, was on science and mathematics rather than on pedagogy, and the universities and colleges that give institutes of both types developed, in many cases, special courses to meet the teach-

ers' special needs. The number of academic-year institutes will jump from two in 1956–57 to 16 in 1957–58.

The foundation's efforts to improve the teaching of science and mathematics in high schools has had a widespread appeal; in the 1957 budget, Congress included $5 million more for this purpose than the foundation had requested. The history of the foundation's summer institutes also illustrates both the possibilities and some of the difficulties of foundation leadership. Similar institutes, with financial support from industry, had been running for several years before the foundation entered the field. The foundation's entry apparently had an encouraging effect on the development of additional industrially supported institutes. But this good effect has been partially canceled, and perhaps even reversed, by the recent great increase in the number of foundation institutes and by the fact that the stipends offered to participating teachers have been larger than those given to most of the teachers who attend the industrially supported institutes.

Dissemination of Information

The rapid increase in amount of scientific publication makes it more and more difficult to locate and secure those research reports that are pertinent to a particular study. The foundation has interested itself in several aspects of this problem. It has given financial assistance to several abstracting services; it has cooperated with the Library of Congress in developing a center for storing and duplicating translations of foreign materials; it has arranged with several scientific societies for the regular publication of English translations of Russian research reports; it has supported studies of automatic or machine translation, and, to increase the background of knowledge upon which such efforts must draw, has supported fundamental studies of language and linguistics.

To make the large number of research reports that are published within the Federal Government more readily available, the foundation supports a report reference service in the Library of Congress. More recently it has established its own Government Research Information Clearinghouse, from which a research worker can secure help in locating information about Government-sponsored research in his field.

Scientific Manpower Register

In 1952 the foundation assumed responsibility for the National Scientific Register, which had been established earlier at the instigation of the National Security Resources Board. When the foundation itself studied the operation and use of specialized manpower rosters, it decided to decentralize the register by using the resources of the specialized scientific societies. Accordingly, contracts were written with a number of societies (for example, the American Chemical Society and the American Institute of Physics) to maintain registers in their fields. These separate registers are conducted on a coordinated basis and can, if conditions ever require, be quickly combined into a single and centrally administered register.

National Science Policy

Three passages in the basic legislation define the foundation's policy-forming responsibilities. One is the clear mandate "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." The other two are "to appraise the impact of research upon industrial development and upon the general welfare" and "to evaluate the scientific research programs undertaken by agencies of the Federal Government."

As was described earlier, the foundation has made a number of policy decisions to guide its own operations. It has been on perfectly safe ground in these matters, for it has been dealing with its own activities and has not encroached on the preserves of any other agency. How much farther should it go? The basic legislation requires interpretation. It seems clear that the Congressional instructions "to develop and encourage the pursuit of a national policy" were not meant to be limited to the foundation's own research-supporting activities. Surely Congress did not create a National Science Board of 24 distinguished leaders of science, education, and public affairs solely for the purpose of settling the issues that arise in the normal operations of the foundation itself. Without minimizing the importance of these issues, it seems clear that Congress must have expected the National Science Board to play a larger role, to go beyond the confines of the foundation's own operations, and to establish *national*—as contrasted with *foundation*—policy. The instructions to evaluate the programs of other agencies and to appraise the impact of research on industrial development and general welfare support this interpretation.

How to carry out these larger responsibilities has been a source of considerable puzzlement. Basic work in science is not amenable to central coordination, and scientists oppose vigorously any attempt at direction and control. Clearly, the policies of the foundation cannot be dictatorial ones. Equally clearly, if the foundation is to exercise a constructive influence on the development of research and education in the sciences, it has to do more than merely approve the existing state of affairs. Understandably, therefore, the foundation has moved cautiously into its area of policy-making responsibility. Moreover, the foundation is not the only federal agency that supports research. The potential friction and jealousies confronting a fledgling agency that tried to "evaluate" the programs of other, and frequently much larger, federal agencies are obvious.

Nevertheless, the foundation was given responsibility for policy. In carrying out that responsibility it was obviously necessary to start with things as they were, for the foundation came into existence after many other scientific agencies were already at work and after the policies that guided their operations had already been established. This fact seems to have been overlooked by some of the foundation's critics; they have acted as if no policy existed prior to the foundation's establishment, and as if the foundation should suddenly create policies. This is unrealistic. The foundation might modify existing policies; it might recommend directions of change that seemed desirable; it might study what has worked well and what less well in the past and make recommendations on that basis. Through such means the foundation might evolve changes and improvements in policy, and to support those changes it could keep Congress, other agencies, and the scientific community aware of the directions in which it sought to move and the future policy goals that it considered desirable.

During the foundation's beginning years there was comparatively little emphasis on these matters, for the foundation deliberately chose to get its operating programs started first and not to devote much of its energies to policy matters until it had established its position in the scientific world. Some critics were dissatisfied with this course and kept urging the foundation to move more rapidly.

In 1954 the foundation, the other interested agencies, and the President's office prepared an executive order (*6*) that defined more clearly the responsibilities of the principal federal agencies that had research interests. Each agency that had scientific interests was given authority to conduct and support basic research in fields closely related to its operating responsibilities. The foundation was given the wider responsibility of supporting general-purpose basic research. In order to maintain this division of responsibility, the heads of other agencies with research interests were instructed to keep the foundation informed of their activities and to keep their own applied work under review to make certain that it was undertaken with appro-

priate consideration for the existing knowledge in underlying basic fields.

The Executive Order also instructed the foundation to review the research programs and activities of the Federal Government, in cooperation with the federal agencies concerned, and to make recommendations to the heads of the other agencies involved; to make studies and recommendations concerning research, scientific manpower, resources, and the foreseeable needs of the nation; and to recommend to the President policies for the Federal Government that would strengthen the total scientific effort and help to define federal responsibilities within that effort.

Here was clarification. The foundation was made the principal adviser to the rest of the Federal Government on all of its research activities. Moreover, it was given responsibility for surveying national (federal and nonfederal) research, manpower, and resource needs and for making appropriate recommendations. A clear-cut example of a policy decision under these general powers was the foundation's recommendations, in 1956, that the Government should terminate its research efforts to develop a substitute for natural rubber and that the Government laboratories for this purpose should be transferred to private hands. These recommendations were approved.

Against the background of the executive order, and to judge by its own actions, the foundation seems to have defined its policy responsibilities as being of two types: (i) The collection and dissemination of statistical and other information—concerning trends in science, scientific personnel, and the support of science—that may be used as a basis for policy; (ii) the issuance of statements concerning conditions that are considered desirable for the advancement of science.

Information as Basis for Policy

This was the first policy function to be adopted. It has accounted for much the largest portion of the expenses that the foundation classifies under the heading "National science policy studies" (Table 2).

The foundation publishes annually a report entitled *Federal Funds for Science* (7). Each report gives figures on obligations and expenditures for three consecutive years. Various breakdowns present detailed information, by field of science, government agency, type of expenditure, and so forth, of the money the Federal Government is investing in research and development. Other reports have also appeared: the foundation has studied the financial support of graduate students (8) and the demand in industry for scientists and engineers (9); it reports, at regular intervals, the grants made by federal agencies in some fields of science (10); its "fact book" on scientific manpower (11) is the best single source of statistical information on the number and characteristics of scientists in the United States. The information in these reports is valuable to many persons and grows increasingly so as reports on the same topics accumulate and permit the study of trends in the support of science.

Foundation support is enabling three fields of science to make detailed studies of their own occupational characteristics, problems, and trends with respect to research, manpower, and education. These studies of the fields of mathematics, physiology, and psychology will furnish information that will be useful to members of those fields in a variety of policy decisions, in planning educational programs, and in assessing current developments.

In its statistical studies and in its support of the analysis of individual fields of science, the foundation is in an admirable fashion fulfilling its own first definition of its policy role: the provision of useful information.

Some of the science legislation bills that were considered in Congress would have given the foundation responsibility for coordinating the scientific activities of other federal agencies. Other bills would have required the foundation to coordinate its own program with those of other agencies. There was obvious disagreement about the proper relationship between the foundation and other agencies that had scientific interests. The disagreement has continued. As was pointed out earlier, the President's executive order of 1954 instructed the foundation to review other research programs, but to do so in cooperation with the agencies concerned, and to make recommendations to the heads of those agencies as well as to the President.

Some critics would like to have seen the foundation enter with a reformer's zeal into the task of reviewing the activities of other agencies, but they have not presented evidence that great reform is necessary or that strong action would have been effective. The foundation has decided that a quieter and truly cooperative type of review is its proper course of action and has begun to make such reviews when requested to do so by another agency.

While reviews of other agencies have not been a major feature of foundation activities, reviews of the support given to the different fields of science have been. The foundation and other federal agencies that support research exchange information concerning applications received and grants made. Thus, the foundation staff member who is responsible for work in any particular field is aware of other work in his field that is being supported by the Government. He and his advisory panel also keep informed of work being done outside of Government. This information is used by the foundation in determining the support that it gives to a particular area of research and provides, for all of the agencies concerned, a continuous overview of the distribution of support among the fields of science.

In addition to having an information-gathering and advisory role with respect to purely scientific matters, the foundation has an advisory role with respect to decisions that are made primarily on other grounds but that have an influence on scientific progress. It has an opportunity to play a peculiarly constructive role in such problems, for it has the whole of science as its realm of interest while other agencies have their centers of interest somewhere else. Yet these other agencies make decisions that influence scientific developments. The Atomic Energy Commission decides to give nuclear reactors to schools of engineering so that more young engineers will be acquainted with nuclear technology. The Selective Service System decides to induct or to defer graduate students who are approaching age 26. The Department of Defense decides to place great emphasis on research and development leading to a particular new weapon. In none of these cases should the effects on science be the sole determinant of whether the program is approved. But science and scientists will be affected by the decisions that are made. As the chief scientific adviser to the rest of the Government, the foundation has an opportunity to make clear—insofar as it can see clearly—the implications of such decisions for the scientific welfare of the country. How extensively the foundation has engaged in this advisory function is not known. Advice can frequently be most useful if given quietly and without public notice. To the extent that it is given in this fashion, it does not appear on the public record.

Statements of Policy

To some persons, a policy is a formal pronouncement. Examples are easy to find; the Cabinet member or agency head who announces, "It is our stated policy that . . ." and the document that begins, "Henceforth it shall be the uniform policy of the . . ." are well known in Government circles. The President seemed to have this type of policy pronouncement in mind when, in his budget message for 1952, he told Congress: "the Foundation will formulate a broad national policy designed to assure that the scope and the quality of basic research in this country are adequate for national security and technological progress."

This statement embodies a quite different concept of policy from the one illustrated by the foundation's information-gathering activities. There probably never will be "*a* broad national policy [on scientific matters]." At least, the foundation has shown no evidence of trying to write one, and probably their answer to anyone who suggests that they should would be, "Go ahead and try it!"

The foundation has, however, made a few formal statements of policy concerning matters of broad interest and importance. The foundation itself lists several such cases (including policy recommendations concerning federal responsibility to aid in the training of scientists and science teachers—matters that were considered earlier in this article).

Increased support for basic research. On a number of occasions the foundation has stated that support for fundamental or uncommitted research is at too low a level in comparison with the support for applied and developmental research. Because it is easier to secure legislative and popular support for research that has an obvious bearing on such practical matters as military technology or the cure of disease, it will undoubtedly continue to be necessary to hammer away at the importance of basic research, even though the rate at which the foundation's own budget has increased is an encouraging sign that the foundation's insistence on the importance of basic research is being heeded.

Considerations of loyalty in connection with grants for nonclassified basic research. Probably all thoughtful observers agree on the necessity for inquiring into the loyalty and security of scientists who are working on classified problems. But judgments vary about the appropriateness of these considerations when the work is not classified. In a period in which extremists were willing to disqualify a person from receiving federal support for research on unclassified problems if charges—even unverified and untested ones—were raised concerning his loyalty, the foundation courageously proclaimed and followed a policy that was subsequently adopted by the National Institutes of Health and that the President, on recommendation by the National Academy of Sciences, announced as Government-wide policy (*12*). Under this policy the foundation does not knowingly support anyone who, either by admission or conviction, has been shown to be disloyal to the United States but in all other cases makes its decisions concerning the support of unclassified research solely on the merit of the proposal and the experience, competence, and integrity of the investigator, as judged by scientists who have a working knowledge of the investigator and the research area in which he plans to work.

Overhead on research contracts. With the rapid growth of Government support of research since World War II, there has been much interest, and some confusion, in the matter of payment for the indirect costs of research. Universities do not keep such detailed cost accounts that they can accurately separate the costs of instruction from the costs of research. When the same faculty member engages in both teaching and research, when he uses his research program as a means of teaching his advanced students, and when he sometimes dips into the same supply for research and teaching materials, it would be costly to maintain the detailed records that would completely separate research from instruction costs. In contrast, Government agencies that are more familiar with procurement contracts than with the support of research insist on detailed cost accounting. The result, over the years, has been that different agencies have allowed different amounts for overhead on research grants.

To prevent such confusion, the military services, after extensive discussion with university officials, developed what has come to be called the "Blue Book" as a guide to the determination of allowable indirect costs. The problem remained, however, and in 1954 the Bureau of the Budget requested the foundation to study the whole matter of payment for indirect costs of research and to recommend policies that could be uniformly followed by the several federal agencies. The foundation complied with this request and recommended that indirect costs be paid to universities when the university requested such payment; that the university have some option in deciding how indirect costs were to be computed; that when a university has selected its preferred method of determining indirect costs, all federal agencies pay at the same rate; and that, to protect the public interest, the Government reserve the right to determine an appropriate overhead rate when the option selected by a university results in a rate that is significantly higher than 25 percent of the salaries paid to members of the project staff or that exceeds the rate determined in accordance with "Blue Book" principles. The foundation estimated that, during 1956, the uniform adoption of these recommendations would have increased federal research costs by not more than $8 million.

Unfinished Business

Any foundation faces the dilemma of following in the traditions established by other foundations or of striking out on newer and bolder pathways. If it follows traditional patterns and has little money, it can expect to add only bits and pieces to what is already being accomplished, but it will be reasonably free from criticism. If it acts with boldness, it is certain to be criticized and likely to make some fairly serious mistakes, but it also stands a chance of accomplishing a great deal more than it would have achieved in more traditional ways.

The National Science Foundation has not had as much freedom to chart its own course as have the private foundations. Dependent as it is on annual appropriations from Congress, the foundation has been limited in the extent to which it could depart from traditional patterns. Another conservative force has been the foundation's relations with other federal agencies. Under these circumstances the foundation started out on the path of conservative operation. What its future practices will be is not clear, but there has been a broadening of operations into newer areas, and a somewhat bolder approach may develop after the foundation has established its reputation and gained the full confidence of scientists, Congressmen, and representatives of other agencies interested in research. Reading, seriatim, its six annual reports gives one an impression of increasing confidence on the part of the foundation and a basis for belief that the next few years may see more boldness than have the earlier ones.

Nevertheless, there are major problems that have important long-run implications for the welfare of science but that have not yet been seriously studied, either by the National Science Foundation or by anyone else. The two following examples are intended not to exhaust the list but to indicate the range of difficult policy issues that can be tackled more appropriately, and probably more effectively, by the National Science Foundation than by any other agency.

Policies of other agencies. The foundation's own policies affect science. So do those of other agencies, sometimes in unknown ways. An interesting example is the scheme for circumventing Civil Service salary limitations by contracting with a nongovernmental institution to provide services that the Government agency might itself perform. Recently the Department of Defense contracted with five universities to establish and manage the Institute for Defense Analysis, to replace the Weapon Systems Evaluation Group that had operated as an in-service Government agency employing Civil Service personnel. The function continues to be that of comparing and evaluating the weapons and weapon systems developed by the Army, Navy, and Air Force. The announced reason for the change was that each of the three services maintained a similar organization on a contract basis and that the Department of Defense could not compete with the individual services in employing scientists and engineers of high quality unless it also used the contract basis.

There are some administrative advantages in operating through a contract, and greater flexibility is sometimes achieved in this way. Moreover, the contract relationships have given the military services access to the specialized competence of many individuals who would not be willing to accept Civil Service appointments. The liaison thus established with civilian science has advantages. On the other hand, there are disadvantages in a dual system. Scientists employed on a Civil Service basis within the Government have had their status disparaged, and competition for employees has occurred. The assumption by a university laboratory of responsibility for applied work has not always been advantageous to the university. The point of these statements, however, is not to decide whether it is desirable or undesirable to have a dual system of in-service and contract-managed scientific installations; the problem is too complex to admit of a simple yes-or-no answer. The point is that the foundation is responsible for advising the President on matters of broad scientific policy and for consulting with other federal agencies on the problems that affect scientific progress. The proliferation of contract agencies may strengthen the total scientific resources of the federal departments or may detract from the in-service research laboratories and weaken the bonds of confidence, common purpose, and day-to-day contact between research man and administrator. Certainly, the foundation has no ready answer to this problem. But neither does it have a vested interest in any particular answer or management system. Who better than the foundation could watch the situation, point out the implications of various methods of managing research programs, study the effectiveness—and perhaps the growing or declining effectiveness—of research installations, and express the best judgment of thoughtful and impartial advisers?

Size of research budgets. It takes only relatively brief discussion with university presidents to uncover a considerable body of uneasiness about the long-term effects of the rapidly increasing federal expenditures for research and development and the heavy concentration of funds on the physical sciences. The Federal Government has become the major source of research funds for some of the universities. What are the effects of this situation on the education, utilization, and distribution of scientists, on education in other fields, on the ways in which the Federal Government is using its powers to influence the development of science? The university officers and faculty members who ask these questions are well aware of the national need for a large-scale scientific effort and they appreciate the role of the universities in that effort, but they also want to guard the universities against distortion and damage that might result from too great emphasis on one aspect—even on one very important aspect—of a university's function.

There are other questions that are raised by the size of current research budgets. Are we getting diminishing returns for our expanding research budgets? Are there adequate means of maintaining an appropriate level of support for important, but in the public eye less popular, areas of research? Decisions made on the basis of little knowledge nevertheless influence the trends being considered, and such decisions are made every day.

The foundation has recognized these questions. Its own studies have provided most of the available information. It has recommended policies for the payment of compensation for the indirect costs of research. It has repeatedly stated that too small a fraction of the total research budget of the nation is being devoted to basic research. But the heart of the problem remains untouched. With appropriations for research going steadily upward, with the belief generally held that there are not enough well-qualified research scientists, and with the statement frequently made that the limitation on scientific progress is men and not dollars, the question is inevitable: Where are we heading?

There are obvious difficulties in tackling such problems as those just described, and there is no guarantee that every effort will be wholly successful. The problem of understanding the effects on universities of the greatly increased level of Government support for research and development illustrates at least one of the difficulties. There has been much enthusiasm for the greater amounts of money available for the support of science, but there are also widely held fears that the current emphasis on science may work to the detriment of the humanities and social sciences; that the emphasis on project research and applied problems may work to the detriment of basic uncommitted research; that the team approach and the formal project, with its deadlines and required progress reports, weaken the research training of graduate students; and that perhaps in other ways long-term values are being sacrificed for short-term objectives. Whether these attitudes—both the enthusiasm and the fears—are justified or not, they exist, and attention should be given to them. Certainly the scale and pattern of financial support for research have changed drastically in the past decade, and the changes have undoubtedly had important effects on the character of university organization and university education. It would be highly desirable to begin to study these effects.

The foundation initiated such a study several years ago. The study committee gave careful and constructive thought to the matter of overhead payments on research contracts but, so far, has not reported on the other, and more fundamental, problems. Perhaps this early concentration of attention on one aspect of a broad problem was due to the inherent difficulties of the other aspects. Perhaps it indicated the special interests of the committee members. In any event, the educational world is still waiting for a report on some major issues that the foundation hoped to study constructively.

Regulation and Control?

In addition to the policy functions considered in the preceding section, some of the foundation's critics would have it go still farther beyond its basic function of promoting science. They have wanted the foundation to help Congress or the President control the budgets and programs of other agencies.

Some critics are not content to have the foundation establish policy for the promotion of basic research and education in the sciences but would have it also assume responsibility for initiating actions and recommending policy that should be adopted in response to, or as a result of, developments in science. An illustration will make the distinction clear. In 1956 the National Academy of Sciences published a series of reports on the biological effects of atomic radiation and made a number of recommendations for action. The foundation, instead of the National Academy of Sciences, *might* have carried out these studies and made these recommendations. Perhaps, however, it should not; perhaps the nongovernmental status of the National Academy of Sciences makes it the more disinterested, and hence the more appropriate, agency for such difficult judgments. The question is, should the foundation, in terms of its Congressionally given responsibility, make such studies and recommendations—if not on the biological effects of radiation (since that was done by the Academy), then on other actions that the Federal Government or the nation as a whole should take in response to developments in science?

There is growing sentiment that someone should be seriously and continuously concerned about such issues. Because no agency has accepted this kind of responsibility, many are being urged to do so—the National Science Foundation, the AAAS, and others.

If the foundation were to attempt to determine the budgets for other federal agencies and if it were to attempt to tell the nation what should be done as a con-

sequence of scientific findings and developments, two great difficulties would immediately become apparent. First, the foundation would be assuming responsibility for formulating policy in areas which extend far beyond its authority for regulation and enforcement. It is quite true that, within carefully defined limits, other federal agencies have both scientific activities and regulatory powers; pure food and drug laws and various other safety measures are examples. But the foundation does not have regulatory authority; it can only advise.

If it did have regulatory authority, the second difficulty would arise. The concentration in a single agency of such colossal power over the whole course of science would almost certainly alienate the general scientific support that is essential for the foundation's success.

There have been several attempts in past decades to establish a federal department of science or, through other means, to bring about strong central coordination of federal scientific effort. Every one of these efforts has failed. In discussing the attempts and the reasons for their failure, A. H. Dupree has analyzed the requirements for a successful central coordinating agency. Among the requisites, such an institution would have to have "not only a legal authority within the government, but a moral authority with all the estates of science in the country and a position of honor among the great scientific societies of the world. . . . In the twentieth century, government research became so colossal that by its use of funds and personnel it could control the dynamics of the other estates of science. With this dominant position, the approbation of all science became an absolute necessity. To be truly representative of the varied interests of the professional natural scientists, engineers, and social scientists who demand a voice implies a certain amount of independence in the face of the government's interests. The need for reconciliation of the government's legitimate demand for responsibility and the scientists' essential stake in independence is one way of stating the unsolved dilemma of all attempts at central scientific organization" (*13*).

If Dupree's analysis is sound, an attempt by the foundation to adopt as strong a role as some of its critics seem to demand would guarantee its collapse and failure.

The National Science Board appears to have recognized this danger, for it explicitly rejected the belief "that government can and should direct the course of scientific development in this country." In commenting on this decision, the chairman of the board wrote: "It is clearly the view of the members of the National Science Board that neither the National Science Foundation nor any other agency of the Government should attempt to direct the course of scientific development and that such an attempt would fail. Cultivation, not control, is the feasible and appropriate process here" (*14*).

Over-all Appraisal

Each friend and each critic of the foundation is entitled to his own appraisal of how well it has done, of how the progress of science has been influenced by the foundation's existence, and of how well it has measured up to his expectations. On the basis of a fairly close acquaintance, since 1946, with the problems of bringing the foundation into being and getting its activities started, I feel more complimentary than critical. If the pace of development has sometimes seemed slow, that is less important than the direction of movement, and the foundation has moved progressively in what seem to be desirable directions. If the pace has seemed slow, one must also remember the puzzling problems of a new federal agency that was established with some doubts about its necessity and some limitations on its activities. If, in spite of these difficulties, one wants to be severely critical, he should have a well-thought-out answer to the question of how he, under similar circumstances, would have guided the foundation in its first 6 years.

References and Notes

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3. Public Law 507, 81st Congress, the National Science Foundation Act of 1950. The Act includes two additional functions, neither of which, in practice, has been of major importance: to carry out research connected with national defense, when requested to do so by the Secretary of Defense, and to establish such special commissions as the National Science Board deems necessary.
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H. H. Goddard and the Hereditary Moron

If the early history of mental deficiency may be said to date from Itard, so its later "vogue" dates 100 years later from Henry Herbert Goddard. From the Wild Boy of Aveyron, at the end of the 18th century, to the modern understanding of mental retardation of today is more than a span of 150 years; it marks the transition from an era of ignorance and callous feeling to one of enlightened human acceptance. And for the last 50 of those years we are most heavily indebted to the "discovery" of the moron. For the heartsick parents of the mentally retarded and their children who never grow up all owe Goddard a debt which far transcends his scientific research and the many social ramifications of his effective publications.

There have been periods when the feeble-minded were considered *les enfants du bon Dieu*, and others when they were thought to be inhabited of devils. In our time they have been the intermittent objects of faltering scientific inquiry or of maudlin welfare sentiment. Their very designation has moved from such terms as *idiocy*, to *imbecility, feeblemindedness, mental deficiency*, and now an ambiguous *mental retardation*, with

oligophrenia as a self-conscious attempt at a more professional designation.

Coming into this field from the teaching of Westchester (Pennsylvania) Normal School classes in psychology in 1906, Goddard, at the instigation of the superintendent, E. R. Johnstone, founded the first full-time research laboratory on mental deficiency at the Training School at Vineland, New Jersey—a happy personal association of two men of great vision, humanitarianism, and scientific dedication. Well oriented by his Quaker birth and rearing, and deeply inspired by his professional association with G. Stanley Hall and the new child-study movement welling up at Clark University, Goddard felt called to a lifework which was to bring hope to a world where humility and a sense of belonging were to guide his fruitful efforts.

As if the gods were on his side, and he their agent, the Binet-Simon scale appeared on the scene as Goddard was searching for an effective approach to his new endeavors. Translated by him into English, and standardized on a then reasonably adequate American population, this scale brought crucial assistance to his task. At once he became an advocate for the scale and its acknowledged chief American exponent. This opened the way for a new classification of the feebleminded, which in turn illuminated the educational, social, and occupational potentials of the mentally subnormal in ways previously imagined but not very successfully pursued. This also led to a new philosophy of education, based on genetically determined maturational stages of growth, which is today a commonplace doctrine.

At that date the term *feeble-minded* was employed professionally as the generic term for all mental deficiency as well as for its highest or marginal degree; that is, *idiot, imbecile,* and *feeble-minded* were the subdegrees of feeblemindedness. To avoid this ambiguity, Goddard coined the word *moron* for the marginal degree while retaining *feeble-minded* for the generic use only. The term caught on and almost overnight attained such wide popular use as to belittle and confuse its considered technical meaning. Thus was popular interest in mental deficiency stirred, but at the ultimate cost of popular misuse of the word *moron.*

For Goddard, research on mental deficiency now became heavily concentrated on its highest degree, moronity. This did not lead to his ignoring the degrees of idiocy and imbecility nor the clinical varieties of amentia. Rather, at the time, the moron was seen as numerically, socially, and educationally the most serious issue.

The major research purpose of the Vineland Laboratory under Goddard was the study of causes and consequences, a phrase incorporated in one of his major books. Preliminary to such study was the need for information on characteristics, including definition, diagnosis, and classification, as well as management and amelioration. An obvious avenue of attack was the study of hereditary transmission. Here an ambitious attempt was made, with the assistance of a corps of competent field workers, to study the family histories of all the resident "children" of the Vineland institution. Davenport had already made sallies in this direction. The Jukes were already widely known. Overnight from other sources came the Nam family, the Hill Folk, the Ishmaelites, the family of Sam Sixty, and many others. Topping all these, the story of the Kallikak family, later to be mocked through the literature as the Kallikak myth, captured public imagination. The dramatic feature of this story was the stemming from a single sire of two parallel related family strains, one "good" the other "bad." Here again Goddard's flair for word coinage gained attention, so that *Kallikak* entered the language as had *moron.*

This is not the place to moralize or to defend, but I recall becoming closely associated with Goddard at the time that the Kallikak book was published, the Binet scale, a two-volume translation of the Binet-Simon articles, and the word *moron* having already "arrived." Granting the difficulties inherent in such a study and the historical, as well as other, limitations of proof, it nevertheless seems to me grossly improper to laugh this epochal investigation out of court as unjustly and as disparagingly as later "students" speciously did. It became fashionable to decry the methods, the data, the treatment of data, and the inferences. Yet the late Elizabeth S. Kite, the field worker for this extraordinary study, was a historian of excellent repute, with acknowledged social *savoir-faire,* well prepared in family history investigation, a specialist in United States colonial history and the author of several standard historical books, well informed on social and mental evaluation techniques, and with other merits. But the tide of revolt or even revulsion had set in, and not Goddard nor Miss Kite nor the loyal Vinelanders felt it seemly or politic to do more than let the disparagement run its ungenerous course.

Then came *Feeble-Mindedness; Its Causes and Consequences,* the arduous summary of all the Vineland field studies. Among these at least two other major-strain histories were left in manuscript, notably the Jackson-White study among the New Jersey Ramapoes and the Kirkpatricks of southwestern New Jersey. "The Pineys" study was published separately by Miss Kite under the auspices of the New Jersey State Department of Charities and Correction. Suffice it here to note that an epoch was deliberately closed, for the moron and the Binet scale had other work to do.

Now followed that period when the Vineland Laboratory expanded into the three departments of (i) psychology, including social work, (ii) biochemistry, and (iii) psychopathology, including neuropathology and morbid physiology. Here Goddard encompassed an all-comprehensive psycho-social-biological framework for a total coordination of human appraisal. Meantime he was reaching out into such related areas as crime and correction, juvenile delinquency, education, industrial efficiency, social pathology, and an over-all social philosophy derived from the study of the mentally subnormal and abnormal. Much of this was summarized in his *Psychology of the Normal and Subnormal,* but not so successfully as he had hoped. Other books and a continuing flow of journal articles and public addresses reflected the enormous productivity of his energy and wide-ranging imagination.

Then came World War I and the sharing in the movement for mental measurement and classification in the U.S. Army, followed by the move to Columbus as director of the Ohio Institute for Juvenile Research and a happy return to teaching at Ohio State University until retirement. Coincidentally his active support of the workshop for gifted children in the city of Cleveland complemented his interest in the mentally retarded.

In so rich and productive a life the obituarial recital of details found in *Who's Who,* or of publications listed in standard bibliographic sources, seems almost irrelevant, however informing and revealing. I am grateful to Goddard as a person, teacher, and many varieties of hero. Generous without stint, he never withheld ideas or data or materials of any kind from one seeking them. He feared no pirating of ideas, having always a mythical pitcher welling with more than he gave away. He was warmly regarded for his honesty, candor, humor, consideration, humility—and sensitiveness. Sought as a speaker, respected as a writer, revered as a teacher, he lived the full, good life. Yet he grieved with deep hurt at the detractions of the thoughtless and the captious.

In a real sense he belongs with and to the moron and the Kallikaks—their best friend and most benevolent proponent.

EDGAR A. DOLL

Bellingham, Washington

News of Science

Power of Radar Increased

The U.S. Air Force and Columbia University have announced the development of new techniques that increase the power of radar in "extremely large, effective amounts." At a press conference John R. Dunning, dean of the Columbia School of Engineering, described the increased effectiveness as "many hundreds of times" by comparison with World War II radars. Dunning also called the work "probably the greatest single advance in radar work since the start of World War II."

The 3-year research project was carried out in the Electronics Research Laboratories at Columbia under an Air Force research contract. The sponsoring agency was the Rome, N.Y., Air Development Center of the Air Research and Development Command.

The new techniques do not actually increase the power used, but instead employ a method of "signal enhancement" which raises the strength of a radar signal reflected from an aircraft or a missile "to an unprecedentedly high level." This has particular significance for radar installations in regions like the Arctic, where it is extremely difficult to supply fuel and other facilities for producing large amounts of power.

Oreopithecus bambolii

In June of this year, I spent the better part of a week in Basel, Switzerland, studying the specimens of *Oreopithecus bambolii* which Johannes Hürzeler has assembled at the Natural History Museum from various European collections.

Oreopithecus is a fossil catarrhine or Old World pithecoid primate from the Pontian (Upper Miocene or Lower Pliocene) of Tuscany, Italy, roughly some 10 million years in age. It is a highly controversial creature which has given rise to diverse interpretations since Gervais first described the type specimen, a mandible with teeth, in 1872 [*Compt. rend. Acad. Sci.* **74** (1872)]. Some authors have regarded it as a peculiar anthropoid ape, others as an aberrant cercopithecoid or Old World monkey, and still others as a sort of *forme de passage* or link between the two preceding groups. Majority opinion, however, labeled it a cercopithecoid of some sort. There the matter rested until 1954, when Hürzeler [*Verhandl. naturforsch. Ges. Basel* **65**, 88 (1954)] rescued *Oreopithecus* from paleontological oblivion by the startling claim, based on detailed study of the dentition, that this animal actually is not only a hominoid—that is, a member of the taxonomic group that includes the pongids (anthropoid apes) and hominids (man and his immediate forerunners)—but, more precisely, a primitive hominid and hence a representative of the specific evolutionary line that led to man.

The material which Hürzeler has brought together at Basel comprises the remains of at least 50 different individuals. Although teeth and jaws predominate, some important parts of the skeleton of both the trunk and the limbs are included.

The dentition of *Oreopithecus* is not, as is often claimed, of a cercopithecoid type. Indeed, it is typically hominoid, although of a generalized nature. Moreover, it is not pongid; rather, it exhibits a number of characters which can be regarded only as hominid.

Knowledge of the skull is as yet incomplete. Even so, the known portions of cranium and jaws exhibit features which suggest that the skull of *Oreopithecus* was hominid, rather than pongid, in pattern.

The available limb bones or fragments thereof (especially the proximal part of an ulna, some hand bones, and the major portion of a foot which has not yet been completely freed from its matrix) appear to be those of a hominoid more generalized in limb structure than existing pongids. In some characters they are, in fact, hominid. In other characters, the resemblance is closer to cercopithecoids than to pongids; such characters are best interpreted as generalized catarrhine ones. The present picture of the extremities, although admittedly quite fragmentary, is by no means incompatible with what might be expected in an early hominid.

Portions of the vertebral column of two animals have been recovered: (i) parts of the last three lumbar (of which the two more caudal ones are largely complete) and the first two sacral vertebrae (the second of which is fragmentary), and (ii) most of the sacrum. These are distinctly hominoid, and in no manner cercopithecoid. Indeed—startling though this suggestion may seem to be—the lumbar vertebrae are so relatively large and robust as not to exclude the possibility that *Oreopithecus* was capable of walking upright! On the other hand, their massiveness may be in the nature of a preadaptation.

It appears that the most reasonable interpretation of the available *Oreopithecus* material is that this animal not only is a hominoid but actually belongs to the hominid line of that evolutionary radiation. There is no good reason for regarding *Oreopithecus* as a pongid of any sort. Nor is it any sort of cercopithecoid, aberrant or otherwise, as has again, recently, been claimed by Remane [*Akad. Wiss. u. Lit., Mainz, Abt. Math.-naturw. Kl.*, 469 (1955); *Primatologia* **1**, 267 (Basel, 1956)] and von Koenigswald [*Riv. Sci. Preist.* **10**, 1 (1955)]—an interpretation to which Robinson is also inclined [*The Dentition of the Australopithecinae* (Pretoria, 1956)]. These writers have considered only the teeth; yet Hürzeler has made it clear that even the teeth are not truly cercopithecoid in pattern.

Although *Oreopithecus* is, in the present state of our knowledge, best classified as a hominid, there is, of course, no way of knowing whether it represents a form directly on the line leading to man, for the hominid line of evolution, like other vertebrate lines, quite likely produced more than one branch. In any event, this in no way decreases the probable significance of *Oreopithecus*; for, if the foregoing assessment of its zoological affinities is valid, this Tuscan primate represents our first glimpse of a Tertiary hominid of any sort. One cannot, naturally, overlook the possibility that *Oreopithecus* is a representative of some hitherto unknown line or radiation of Old World primate evolution quite independent of the hominid, pongid, and cercopithecoid lines. This interpretation is unwarranted, however, on the basis of existing evidence and, hence, on the principle of parsimony.

In this evaluation of the status of *Oreopithecus*, I am in essential agreement with Hürzeler [1954; also *Problèmes Actuels de Paléontologie* (Paris, 1956), pp. 115–121] and also with Heberer [*Primatologia* **1**, 379 (Basel, 1956); also see de Terra, *Science* **124**, 1282 (1956)]. A detailed description of the *Oreopithecus* material is being prepared by Hürzeler.

A lignite mine at Baccinello (Gros-

seto), Italy, has proved to be a unique and most prolific source of specimens of *Oreopithecus*. This source has been and is being assiduously utilized by Hürzeler with the full cooperation of the miners (also see de Terra, 1956). As I write, I have before me a letter from Hürzeler, written from Baccinello on 11 July 1957. In it he states that on his recent arrival there he found awaiting him a large number of new specimens of *Oreopithecus*, some of which appear to be of prime importance. He adds that the miners at Baccinello make every effort to see that the specimens are delivered to him as intact as possible. The conditions of mining are such, however, that they are unable to prevent damage by the chopping machine. Hürzeler feels certain that virtually complete skeletons have thus been destroyed—truly a tragedy.

I am greatly indebted to Hürzeler for his kindness in providing me with the opportunity to study the specimens of *Oreopithecus* in his custody, as well as for his generous permission to publish the present account of them. I also am greatly indebted to the Wenner-Gren Foundation for Anthropological Research for a grant which made my visit to Basel possible.

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Wasp Collection

A collection of 5.5 million gall wasps, which was built up by the late Alfred C. Kinsey, Indiana University entomologist and student of human sexual behavior, has been donated to the American Museum of Natural History, New York, by Mrs. Kinsey. In addition to the insect collection, the museum received several hundred volumes used by Kinsey in his research.

Fulbright Awards

U.S. Government awards for the academic year 1958–59 authorized by the Fulbright Act for university lecturing and postdoctoral research have been announced. Awards are made under the auspices of the Department of State and the Board of Foreign Scholarships and are made for the full academic year, but in exceptional circumstances applications will be considered for research for periods of not less than 6 months, or for lecturing for a semester or for the full period of an established summer school. Awards may be made for only one country, and arrangements will be made for those selected to be affiliated with an institution of higher learning abroad.

Awards for lecturers and research scholars made in the currency of the host country usually include round-trip transportation for the grantee (provision is not made for the transportation of accompanying dependents); maintenance allowance which may be adjusted to take into account the expenses of up to four accompanying dependents; a small supplemental allowance for travel in the host country and books or equipment purchasable abroad. Maintenance allowances are calculated on the basis of living costs in the host country and therefore differ from country to country in dollar equivalents. In terms of purchasing power, they are approximately equal.

To be eligible for an award, applicants must be U.S. citizens. Those applying for lectureships are expected to have at least 1 year of college or university teaching experience in the U.S. or abroad. Applicants for research awards are expected to have a doctoral degree from a recognized institution of higher learning in the U.S. or abroad at the time of application, or recognized standing in their respective professions.

Applications for university lecturing and advanced research in Austria, Belgium and Luxembourg, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, the Netherlands, Norway, Turkey, and the United Kingdom and colonial territories must be made no later than *1 Oct.* For application forms and additional information, write to: Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D.C.

Arctic Institute

The 1957 field research program of the Arctic Institute of North America is the most extensive yet undertaken by that organization in a single season. Thirty-seven grants-in-aid have been awarded for northern studies this year, as against 31 in 1956. This year's projects bring the research efforts sponsored by the Arctic Institute, since its founding in 1945, to a total of more than 260.

Twenty-five of the current investigations are in biological sciences, including studies directed toward a better understanding of the physiological adaptive mechanisms of arctic mammals and fishes. The earth sciences are represented by ten of the 1957 projects, including the continuation of long-range microclimatological studies and studies of soil-forming processes.

Two archeological investigations are set at strategic points on the migration routes of ancient man. These may add to the meager knowledge of early man on this continent.

The Arctic Research Laboratory of the Office of Naval Research, Point Barrow, Alaska, the northernmost laboratory on U.S. soil, will be the base for 16 of this summer's studies. The program receives support from the Office of Naval Research, the Canadian Government, the Sir Frederick Banting Fund, and private industry and individuals on both sides of the border.

Tomb in Turkey

A large burial mound of the seventh century B.C. that may be the tomb of King Gordius, father of King Midas, has been excavated in Gordium, Turkey, capital of ancient Phrygia. The tomb was opened by Rodney S. Young, director of a University of Pennsylvania archeological team that has been uncovering ancient Gordium since 1950. The expedition is being financed by the Pew Foundation of Philadelphia. Last year Young found a smaller, timbered wooden tomb containing the remains of a 5- or 6-year-old prince of about the same era of Phrygian history.

Cerebral Palsy Grants

The U.S. Public Health Service has announced grants to New York Medical College and University of Oregon Medical School for research into the cause of cerebral palsy, mental retardation, and allied neurological disorders. This makes a total of 11 medical schools and hospitals which have joined with the USPHS National Institute of Neurological Diseases and Blindness in a long-range nation-wide study in this field.

The investigation is specifically concerned with brain damage that occurs during the perinatal period. It will seek to evaluate such factors as lack of oxygen, brain injuries, blood incompatibility, and infections during pregnancy. Hereditary factors, although they are believed to play a minor role in cerebral palsy and mental retardation, will also be evaluated.

New York State Radiation Code

Violations of the New York State safety code on the industrial use of radioactive materials were found in 6 percent of the plants surveyed during the first 18 months in which the code was in effect. Of the ten plants involved, eight have brought their dose rate down to the prescribed level, one moved out of the state, and one, against which the state has taken court action, has not complied.

Morris Kleinfeld, acting director of the Division of Industrial Hygiene of the

State Labor Department, stated in a report to the State Industrial Commissioner that an advisory committee representing labor, industry, and the public had indicated that it favored establishment of a tighter code and that it had reached "general agreement" that the exposure standards of the National Committee on Radiation Protection should be adopted in New York.

The report states that of ten plants using radium and related products, eight meet present code standards, but only two would meet the standards of the national committee. Of seven plants using neutron sources and particle accelerators, seven meet present requirements, but only three would meet national committee standards.

The state advisory committee is scheduled to meet again in September to make specific recommendations for authorizing the code to maintain a safe atomic industry.

High-Speed Electronic Computer

A new electronic computer, known as MANIAC II (Mathematical Analyzer, Numerical Integrator, and Computer), has been placed in operation at the University of California's Los Alamos Scientific Laboratory. An improvement over the laboratory's MANIAC I in speed, flexibility, and capacity, the machine is operated by the University of California for the Atomic Energy Commission.

The new Los Alamos device differs from other high-speed electronic computers in that it does not contain a built-in "clock" causing it to operate at a certain fixed pulse rate—a feature that allows it to perform successive operations as rapidly as possible without having to pause for a given number of cycles. Typical total operating times are as follows: addition and subtraction, about 18 microseconds (millionths of a second) each, and multiplication, about 170 microseconds.

Similar computers based on the design of MANIAC II are being constructed at Rice Institute, Houston, Tex., and at Brookhaven National Laboratory, Upton, N.Y.

Life Insurance Medical Research Fellowships

The Life Insurance Medical Research Fund is now receiving applications for awards for postdoctoral research fellowships and for grants to institutions in aid of research on cardiovascular problems. Approximately $1 million will be available for the two types of award, which will be available 1 July 1958.

Candidates for the research fellowships may apply for support in any field of the medical sciences. Preference is given to those who wish to work on cardiovascular function and disease or related fundamental problems. Minimum stipend is $3800, with allowances for dependents and necessary travel. Applications must be received before *15 Oct.* For institution grants, support is available for physiological, biochemical, and other basic work broadly related to cardiovascular problems as well as for clinical research in this field. Further information and application forms may be obtained from the scientific director of the Life Insurance Medical Research Fund, 345 E. 46 St., New York 17, N.Y.

Federal Research in Psychiatry

More than half of the Federal Government research projects in psychiatry and psychology reported by the National Science Foundation are carried out by the Veterans Administration. Figures from the foundation for 1 Jan. 1957 show that 568 of 1094 Federal Government research projects in these fields, or 52 percent, are sponsored by VA, as compared with 37 percent in January 1956.

Some 351 of the VA studies pertain to diagnosis and treatment of patients. These make up 91 percent of the 386 Federal Government research projects in psychiatry and clinical psychology. The remaining 217 VA projects are in other fields of psychology and include studies in selection and training of personnel, hearing and vision, learning and motivation, and group relations.

TV Program on Cosmic Rays

"The Strange Case of the Cosmic Rays" will be the next Bell System Science Series TV program. It will be seen on the NBC network on the evening of 25 Oct. This 1-hour color film, the third in the new series, describes the 50-year history of cosmic-ray research.

Producer-director Frank Capra has conceived this research as a detective story whose scope is the entire universe. Scientific material presented during the course of the program includes animation, documentary film, and still pictures of cosmic-ray "tracks," some of which are being presented on television for the first time.

Carl D. Anderson, Nobel prize winner and professor of physics at California Institute of Technology, was the principal adviser for the production. Bruno Rossi of Massachusetts Institute of Technology and Marcel Schein of the University of Chicago were associate advisers. The scientific material in the program was prepared under the general supervision of a nine-member advisory board. Some 22 scientists, eight Nobel prize winners among them, are shown at work on cosmic-ray research, including Anderson, Rossi, and Schein. After its initial telecast, the Bell Telephone Companies will make the program available to schools and other interested groups in 16mm color prints.

Rehabilitation in Poland

Poland has made substantial progress in developing rehabilitation services for war-disabled persons following an overall national plan developed in 1948 and 1949. There are now 600 rehabilitation officers throughout the country, compared with but 30 in 1949.

Prior to Hitler's invasion, Poland had around 13,000 physicians. After the war only 7000 were left. Today the country has 23,000 physicians, and her 10 medical schools graduate 2000 new doctors each year.

Hospital services have been expanded. Before the war Poland had 2.6 beds for every 1000 persons. Today she has 4.3 The goal is six beds for every 1000 of population nation-wide and 12 for each 1000 in Warsaw. Some of the newly built hospitals compare favorably with new hospitals in Western Europe and the United States.

A college-level school of physical therapy was started 3 years ago. Five vocational training centers graduate 1200 physically handicapped trained workers each year, and more than 95,000 disabled workers are employed in cooperative sheltered workshops.

The World Rehabilitation Fund, an American voluntary organization, has offered to provide a fellowship for a Polish prosthetic technician to learn American methods. Through the same organization two Polish physicians are taking postgraduate training in rehabilitation at Western Reserve University. WHO has given 30 international fellowships to Poland for the coming year, and the U.N. is giving three fellowships in rehabilitation.

Bar Harbor Mice

More than 470,000 mice were sent from the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Me., this year to scientists, hospitals, and research centers in countries all over the world. The number of animals shipped this year has greatly surpassed any other year, and an average of 10,000 to 15,000 mice are now being sent out each week. Despite this rise in shipments, the laboratory is unable to meet the ever-increasing demand. A $500,000 addition to the laboratory

that will enable mouse production to expand an additional 300,000 mice per year will be under construction this fall and in complete operation by early spring.

These pedigreed mice are raised as a service to world research, and the Jackson Laboratory is the only center that breeds and constantly renews strains of standard mice. The animals are sold at cost at prices that range from $8 for a dystrophic mouse with a normal control, to 25 cents for retired breeders of some strains.

Each year many shipments of mice leave the laboratory destined for foreign countries. In such cases, the cost of shipping the mice is often far greater than the cost of the animals themselves. For instance, $24 worth of mice being sent to areas throughout Europe cost approximately $140 to ship, depending on distance and mode of transportation.

News Briefs

The Special Training Division of the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn., has announced the following 1958 schedule of 4-week courses in the basic techniques of using radioisotopes: 6–31 Jan., 3–28 Feb., 19 May–13 June, 16 June–11 July, 11 Aug.–5 Sept., 8 Sept.–3 Oct.

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Physical examinations of 86,000 survivors of the atomic bombing of Hiroshima 12 years ago were begun on 1 Aug. to determine whether the survivors have symptoms of leukemia or pernicious anemia.

* * *

Nearly 30 percent of the narcotics addicts in England are in the medical profession, according to a British Government report. There are 333 known British addicts; of these, 77 are doctors, 20 nurses, and two dentists.

* * *

The U.S. Public Health Service has announced that vaccine against Asian influenza is expected to become available to the public during September. The six manufacturers licensed to produce such vaccine have set a production goal of at least 60 million milliliters (doses) by 1 Feb.

Scientists in the News

WILLIAM L. STRAUS, JR., professor in the Laboratory of Physical Anthropology at Johns Hopkins University and a member of the AAAS Editorial Board, will transfer next month to the department of anatomy in the university's medical school, where he will be professor of anatomy and physical anthropology.

EUGENE P. ODUM of the department of zoology at the University of Georgia has been awarded an alumni professorship for his outstanding work in the field of ecology. In the same department R. BARCLAY McGHEE received the Michael prize for research in the phylogeny of certain flagellated protozoan parasites of insects.

KAZUO K. KIMURA, formerly of the Raymond Blank Memorial Hospital, Des Moines, Ia., has been appointed chief of the neurology branch of the Clinical Research Division, Directorate of Medical Research, Army Chemical Center, Md. He succeeds E. ROSS HART, who resigned early in 1956 to take a research post in the Veterans' Administration Hospital, Pittsburgh, Pa.

WARD DICKOVER, for 29 years a chemical engineer at Gould National Batteries Company, has joined the electrochemistry section of the National Bureau of Standards. He will conduct a research program on basic characteristics of special types of secondary storage batteries. This is part of the section's work on the improvement of aeronautical batteries for advanced aircraft and on the testing of their conformity to federal specifications.

Another appointment at the NBS is that of WERNER C. RHEINBOLDT, a mathematician, who is a member of the computation section of the Applied Mathematics Division. He will perform research on numerical analysis using high-speed electronic computers. Before entering the United States in September 1956 he was employed as an aerodynamic mathematician with the Engineering Bureau of Dipl. Ing. W. Blume at Duisburg-Ruhrort, Germany.

Four new appointments have been made in the department of geology of the Smithsonian Institution (National Museum) to help care for collections and continue research work discontinued by vacancies due to deaths and retirements. PORTER M. KIER, formerly of the University of Houston, was appointed in June to take charge of the collection of fossil echinoderms. RICHARD S. BOARDMAN, formerly of the U.S. Geological Survey but stationed in the U.S. National Museum, transferred to the Smithsonian on 1 July. His primary interest is in the morphology and general paleontology of the Bryozoa. He will carry on the work started by R. S. BASSLER at the Museum more than 50 years ago. Boardman is now finishing work on the morphology of some Devonian trepostome bryozoans, but is anticipating an extensive study of Ordovician bryozoa of the Appalachians and parts of the Midwest. RICHARD E. GRANT has been given a 4-year appointment in the Smithsonian on a National Science Foundation grant to G. A. COOPER. Grant will collaborate with Cooper on a study of the extensive collection of Permian brachiopods from the Glass Mountains, brought together by Cooper during the last 17 years. PETER P. VAUGHN, formerly of the University of Kansas, will have charge of the collections of fossil reptiles and amphibians, and in his research will devote himself chiefly to the late Paleozoic and early Mesozoic tetrapods.

J. C. R. LICKLIDER, associate professor of psychology at Massachusetts Institute of Technology, has been named to direct the scientific activities of the department of engineering psychology of the consulting firm of Bolt Beranek and Newman, Inc., Cambridge, Mass. Another appointment to the same department is that of KARL D. KRYTER, at present director of the Operational Applications Laboratory, Air Force Cambridge Research Center of the Air Research and Development Command, located in Washington, D.C.

SHERWOOD K. HAYNES, professor of physics at Vanderbilt University, has been named head of the department of physics and astronomy at Michigan State University. He will take up his new duties on a part-time basis on 1 Sept. and full time next February. Other appointments at Michigan are as follows. W. W. ARMISTEAD, dean of veterinary medicine at the Agricultural and Mechanical College of Texas, has been named to head the university's College of Veterinary Medicine. He succeeds CHESTER F. CLARK, who will retire as dean emeritus on 1 Sept. JOHN USEEM, member of the Michigan State staff since 1949, has been appointed head of the department of sociology and anthropology. He replaces CHARLES P. LOOMIS, who wished to end a 13-year tenure as department head in order to devote full time to research and teaching. CARL C. TAYLOR, well-known rural sociologist, will be a distinguished visiting professor during the winter term. Taylor, an official of the U.S. Department of Agriculture for nearly 25 years, will teach a course in the American farmers' movement. Upon completion of his stay at Michigan, Taylor plans to return to India, where he served as consultant for the Ford Foundation and the U.S. Department of State for 2 years following his retirement from the USDA.

ROBERT G. CARSON, JR., has become director of instruction in the School of Engineering at North Carolina State College. He was formerly head of the industrial engineering department.

REUBEN L. KAHN, originator of the Kahn blood test for syphilis, has retired after 29 years at the University of Michigan. However, he will continue his research as consultant in the department of dermatology and syphilology. Kahn developed his well-known test in 1922 while working as an immunologist at the Michigan State Health Department in Lansing.

THOMAS C. JONES, lieutenant colonel in the Veterinary Corps, U.S. Army, retired on 31 July, after more than 21 years of active duty, to become pathologist at Angell Memorial Animal Hospital, in Boston, Mass. He will also be a part-time faculty member in the department of pathology of Harvard Medical School and consultant to New England Cancer Research Institute. Jones attended the University of Idaho and received his B.S. and D.V.M. degrees from the College of Veterinary Medicine, State College of Washington, Pullman, in 1935. Following his graduation, he was commissioned a first lieutenant in the Army Veterinary Corps and was assigned as assistant station veterinarian at the Presidio of Monterey, Calif., where he remained until 1938. He then studied at the Army Veterinary School, Army Medical Center, Washington, D.C., and at the Army Medical Field Service School, Carlisle Barracks, Pa.

During the period 1939 to 1945, he was officer in charge of the Army Veterinary Research Laboratory, Front Royal Quartermaster Depot, Va., and Fort Robinson, Neb. From 1950 to 1953, he was chief of the veterinary department and technical division, Fourth Medical Field Laboratory, U.S.A., in Europe. With Hilton A. Smith, he wrote a textbook on veterinary pathology, and he has recently completed a study of a specific viral disease of animals which produces an inflammation of the arteries believed to have some specific application to cardiovascular diseases in man.

H. TYLER MARCY has been appointed by the International Business Machines Corporation as manager of its Data Processing Division's product development laboratory at Poughkeepsie, N.Y. He was formerly assistant manager of product development at the company's New York headquarters.

SAM R. ALDRICH of Cornell University has been appointed professor of agronomy extension at the University of Illinois College of Agriculture. He will specialize in soil fertility.

PASQUALE J. COSTA, instructor in pharmacology at the Harvard Medical School, has been appointed associate professor of pharmacology at Seton Hall College of Medicine and Dentistry.

W. A. PEARSON, professor of biology and biological chemistry at Ferris Institute, Big Rapids, Mich., retired in June after 52 years of teaching. Following his graduation from the University of Michigan in 1898, Pearson was a research chemist for Parke, Davis and Company until 1904, when he began his teaching career at Ferris. He left Ferris in 1906 for Hahnemann Medical College and taught there until 1949. Pearson received his M.D. degree from Hahnemann in 1915 and later earned the Ph.D. degree from Philadelphia College of Pharmacy and the Sc.D. degree at LaSalle College. In the meantime, he served as dean of Hahnemann Medical College until 1944.

WOLFGANG R. WASOW, a member of the staff of the U.S. Army Mathematics Research Center at the University of Wisconsin, has been appointed a professor in the university's department of mathematics.

Another appointment at Wisconsin is that of DAVID T. GRAHAM, at present on the faculty of Washington University School of Medicine, as associate professor of medicine.

GLADYN H. PUTT, long associated with missile research and development, has been appointed executive assistant to L. Eugene Root, vice president of Lockheed Aircraft Corporation and general manager of its Missile Systems Division. Putt will be based at the division's Sunnyvale, Calif., plant. For the past 9 years he has been at Rand Corporation, a nonprofit organization formed by a group of scientists and engineers to carry on studies of advanced weapons and operations for the Air Force.

HAROLD R. DETTELBACH has joined Smith, Kline and French Laboratories, Philadelphia, Pa., as an assistant to the director of exploratory development in the Research and Development Division. He was formerly a pharmacologist-biologist for G. D. Searle and Company, Chicago.

DAVID B. STEINMAN, designer of the Mackinac Bridge in Michigan, the world's largest suspension bridge, will receive the 1957 Louis B. Levy medal of Franklin Institute for his paper, "The design of the Mackinac Bridge for Aerodynamic stability" [*J. Franklin Inst.* **262** (Dec. 1956)].

HAROLD S. DIEHL, dean of the College of Medical Sciences, University of Minnesota, will become senior vice president for research and medical affairs and deputy executive vice president of the American Cancer Society on 1 Nov. For the time being he will be on leave of absence from the university.

HARRY McPHERSON, an engineer who has been technical design test coordinator for Convair in Forth Worth, Tex., has been chosen to head the testing program for the missile weapons system being developed by Temco Aircraft Corporation, Dallas, Tex.

WILLIAM D. STEWART, of Vancouver, Canada, has become the first recipient of the new Maurice Husik prize for his outstanding investigative work while he was a matriculate with the department of dermatology and syphilology of New York University Post-Graduate Medical School. Stewart was the senior investigator and, with VICTOR H. WITTEN, was coauthor of "The measurement of x-radiation received by the gonads during dermatologic therapeutic x-radiation techniques." The paper will appear in the *Journal of Investigative Dermatology*.

MAURICE HUSIK, for whom the prize was named, has been on the staff of the New York Skin and Cancer Unit for 25 years. During this period grateful patients established a fund under his jurisdiction to provide treatment for indigent patients. In July 1956 the Maurice Husik prize was established. The cash amount will vary from year to year, depending on the amount available as income from the Husik Fund, which has endowed the prize.

Recent Deaths

RALPH CHRISTIE, Long Beach, Calif.; 74; first Army flight surgeon; wrote first military manual on physical requirements for flying; 3 Aug.

WILLIAM R. BIRGE, Troy, N.Y.; 37; associate professor of psychology at the School of General Studies at Rensselaer Polytechnic Institute; 4 Aug.

CHARLES McCRACKEN, Eustis, Fla.; 75; author and former president of Connecticut State College; former U.S. Office of Education specialist; 3 Aug.

DONALD P. SMITH, Princeton, N.J.; 78; associate professor of physical chemistry at Princeton University; 2 Aug.

WARD V. EVANS, Lancaster, Pa.; 74; retired chairman of the Northwestern University chemistry department and the lone member of the Atomic Energy Commission's special three-man Personal Security Board of 1954 who ruled that J. R. Oppenheimer was a "loyal citizen"; 2 Aug.

FRANCIS E. DRAKE, Pelham, N.Y.; gas engineer and partner in Drake and Townsend, gas plant engineers, New York; 5 Aug.

JUNIUS D. EDWARDS, Highland, N.C.; 67; former assistant director of research for the Aluminum Company of America; 5 Aug.

Reports

Growth in Sterile Culture of Excised Leaves of Flowering Plants

The successful growth in sterile culture of excised leaf primordia of ferns has previously been reported (*1*). It has been shown that fern leaf primordia of various sizes and ages can be grown to maturity on relatively simple agar media. It has remained a problem to extend this technique, with its advantages of growth on defined medium in isolation from the influences of the whole plant, to morphogenetic studies of leaves of the flowering plants. The present report (*2*) records the successful accomplishment of this objective.

In these experiments, the sunflower (*Helianthus annuus* L.) has been employed the most extensively, but some supplementary trials with tobacco (*Nicotiana tabacum* L.) have been carried out. Both species were grown from seed in the greenhouse. In establishing cultures, the outer leaves of the apical bud were carefully removed, and the inner leaves were excised with knives (prepared from sharpened fragments of razor blades) and planted directly on sterile medium in test tubes. No special sterilization methods were employed for the plant material, since these inner leaves are apparently free of microorganisms. In sunflower the first eight leaves on the shoot (P_1 to P_8) were excised, and in tobacco the first five (P_1 to P_5).

Two media were used for the most part in these investigations, both solidified with 0.8 percent agar. In the simpler of these, Heller's solution of mineral salts (*3*) was used with 2 percent sucrose and a mixture of ten B vitamins (*4*). The more complex medium contained, in addition to these constituents, 15 percent autoclaved coconut milk and acid casein hydrolyzate at a concentration of 1 ml/lit.

The major results of these culture studies are shown in Table 1 and indicate that excised primordia of sunflower are capable of making excellent growth in sterile culture on both the simple and the complex media, showing distinct increases in linear dimensions as well as in fresh weight. There is every indication, particularly from a study of sections of leaves grown *in vitro,* that an organized meristematic development is involved in their growth. The leaves grown in sterile culture clearly attain a condition of maturity, but they are smaller than corresponding leaves developed on the intact plant, as reference to Fig. 1 will show, although there is variation in size in natural leaves depending on conditions of growth. Possible explanations for the small size of cultured leaves have been previously considered (*1*) in the study of fern leaf culture, in which a similar phenomenon has been observed. An additional difference was noted in the shortness of the petiole, or in some cases its almost complete absence, in cultured leaves in contrast with the elongate petiole of natural leaves.

It is evident that sunflower leaves will grow to maturity *in vitro* on a culture medium containing only mineral salts and sucrose as nutrients, with a supplement of B vitamins. It is not at all certain, moreover, that the vitamin mixture is necessary, and this problem will be investigated further. On the other hand, the complex additives, coconut milk and casein hydrolyzate, definitely enhance the growth of leaves in culture, especially the younger primordia. They cannot, however, be considered essential. Table 1 shows the extent of development of the fifth to the eighth primordia of sunflower. The second, third, and fourth primordia have also been successfully cultured, although somewhat greater difficulty is encountered because of the small size of the explants. It may also be noted that results which are essentially similar have been obtained with leaves of tobacco (Fig. 1*D*).

Leaves grown on the media described here present one unusual feature which it would be desirable to overcome. When mature, the leaves are for the most part chlorotic—yellow or whitish in color—and they soon die, unlike the cultured fern leaves, which remain alive and healthy for many weeks after reaching maturity. A partial solution to this difficulty has been found in the incorporation of an ammonium salt into the culture medium. The most successful medium thus far devised is a modification of the simple medium in which sodium nitrate is replaced by ammonium nitrate in such a concentration that the total amount of nitrogen supplied is unchanged from the original medium. On this medium the leaves were, for the most part, bright green in color and remained alive and healthy for several weeks after reaching maturity. Some leaves, however, especially the younger primordia, showed a tendency to become disorganized and to produce masses of callus. It is interesting to note that a comparable addition of ammonium nitrogen to the complex medium did not produce an apparent beneficial effect. The improvement of growth in the presence of the ammonium salt in the simpler

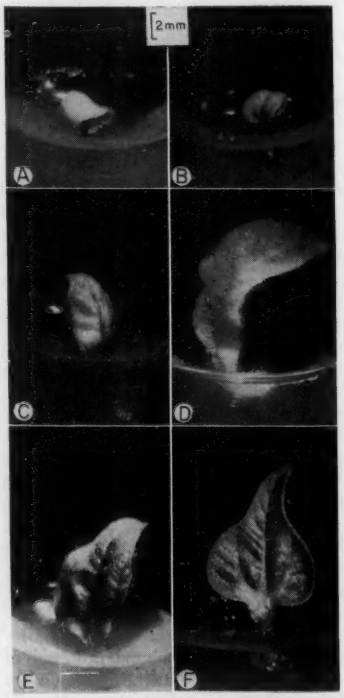

Fig. 1. Excised leaves grown in sterile culture. (*A*) *Helianthus* P_6 on simple medium; (*B*) *Helianthus* P_6 on complex medium; (*C*) *Helianthus* P_6 on simple medium containing an ammonium salt; (*D*) *Nicotiana* P_5 on complex medium; (*E*) *Helianthus* P_8 on simple medium; (*F*) *Helianthus* P_8 on complex medium.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in Science 125, 16 (4 Jan. 1957).

Table 1. Growth of excised leaf primordia of *Helianthus annuus*.

Primordium	Medium	Initial		Final		
		Length (mm)	Fresh wt. (mg)	Length (mm)	Width (mm)*	Fresh wt. (mg)
P_5	Simple	1.1	< 0.1	3.0	1.2	1.2
P_5	Complex	1.1	< 0.1	4.7	2.1	5.8
P_6	Simple	1.8	< 0.1	5.3	2.1	4.2
P_6	Complex	1.8	< 0.1	6.6	3.0	5.9
P_6	Ammonium simple	1.8	< 0.1	9.6	4.2	16.1
P_7	Simple	2.5	0.3	6.2	3.2	8.2
P_7	Complex	2.5	0.3	11.9	5.0	16.8
P_8	Simple	3.4	0.7	14.5	5.4	17.9
P_8	Complex	3.4	0.7	12.3	4.4	18.2

* Width measured at widest point of lamina.

medium is somewhat surprising, since, in general, nitrate is more suitable for the growth of plant tissue cultures (*3*, *5*). It is possible that nitrogen in a reduced form is more easily used by small explants having no roots. On the other hand, it may be that the effect is indirect, through an influence on *p*H which makes certain other ions more readily available. Preliminary experiments suggest that the latter is not the case, but further work on this question is in progress.

The studies described in this report indicate that the technique of sterile leaf culture may now be extended to the flowering plants. As a result, the advantages of growth in sterile culture, on defined medium and isolated from the influence of the whole plant, may now be applied to developmental and physiological studies on angiosperm leaves. In addition, it has been demonstrated in these preliminary experiments that in the flowering plants, as in the ferns, the complex pattern of leaf development is self-controlled within the leaf, once the leaf has been determined at the shoot apex, and is not dependent on continued association with the plant. The youngest primordia cultured, down to the second on the shoot apex, have always, if they have grown at all, developed as leaves, except for a few cases in which a callus was produced. A medium permitting satisfactory development to maturity has been devised, but it is probable that further improvements can be introduced. This is the subject of investigations now in progress.

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References and Notes

1. I. M. Sussex and T. A. Steeves, *Nature* 172, 624 (1953); T. A. Steeves and I. M. Sussex, *Am. J. Botany*, in press.
2. This work was supported in part by a grant to R. H. Wetmore and T. A. Steeves from the American Cancer Society, Inc., upon the recommendation of the Committee on Growth. H. P. Gabriel was aided by a summer grant from the National Science Foundation.
3. R. Heller, thesis, University of Paris (1953).
4. Modified from G. Morel and R. H. Wetmore, *Am. J. Botany* 38, 138 (1951). Contents and concentrations per liter are as follows: thiamine hydrochloride, 10.0 mg; pyridoxine hydrochloride, 1.0 mg; nicotinic acid, 5.0 mg; calcium pantothenate, 5.0 mg; riboflavin, 0.5 mg; folic acid, 0.1 mg; biotin, 0.01 mg; choline chloride, 1.0 mg; para-aminobenzoic acid, 0.5 mg; inositol, 10.0 mg.
5. R. J. Gautheret, *Ann. Rev. Plant Physiol.* 6, 433 (1955).

17 June 1957

Paleobotanical Studies of Canadian Pleistocene Nonglacial Deposits

During recent years I have made a palynologic study of certain nonglacial deposits in the St. Lawrence lowland, Quebec, and in the James Bay lowland, Ontario. The results warrant an assessment of the climate of the nonglacial interval and of the stratigraphic positions of the deposits (*1*).

In the St. Lawrence lowland, the nonglacial sequence is exposed in several sections along the St. Lawrence River and its tributaries, over a distance of 70 mi, from Pierreville to Donnacona, about 25 mi west of Quebec City. In the James Bay lowland, the exposures of nonglacial deposits have been observed on the Missinaibi, Opasatika, Soweska, and Albany rivers (*2*). A sound Pleistocene geologic background for the palynologic studies has been provided by N. R. Gadd (*3*) and O. L. Hughes of the Geological Survey of Canada, who have mapped the Pleistocene deposits in the St. Lawrence lowland and Cochrane areas, respectively.

By oversimplifying matters considerably, it may be stated that the stratigraphic sequence in both areas is composed of a basal set of glacial deposits of unknown age, overlain by a nonglacial sequence which is in turn overlain by younger glacial deposits. Marine and alluvial deposits overlie the uppermost glacial deposits. Radiocarbon determinations made on samples of peat and wood gave an age of more than 38,000 yr (sample W-242) for the nonglacial deposits on the Missinaibi River and more than 40,000 yr (sample W-189) for the nonglacial deposits in the St. Lawrence lowland (*4*). The palynologic evidence indicates that boreal conditions prevailed during most of the nonglacial interval in both areas and that the temperature did not reach a maximum as warm as that of the present. An arctic and subarctic environment is evident at the beginning and close of the interval (relatively high percentages of birch, alder and nontree pollen). Black spruce (*Picea mariana*) and white spruce (*Picea glauca*) were the predominant trees in the early and late parts of the interval. Higher values (40 to 60 percent) of pine pollen (*Pinus banksiana*) in the middle of the interval probably indicate slightly warmer conditions. Alder and birch pollen percentages were low during most of the interval.

In the St. Lawrence lowland, small amounts of white pine pollen (*Pinus strobus*) have been found in samples from the middle and lower parts of the nonglacial peat sequence. In the lower middle part of the sequence, there is a scattered but significant presence (2 to 5 percent) of pollen of temperate deciduous trees (*Quercus, Ulmus, Acer, Fraxinus, Carya, Carpinus, Tilia*). Hemlock pollen (*Tsuga canadensis*) is apparently absent, whereas it is present in all pollen diagrams of post-glacial sediments from the same area. Judging by the geologic and palynologic evidence, a drainage system was established prior to the deposition of the peat sequence. The peat, silt, and silty peat sequence was most likely deposited along wide river valleys.

An attempt to estimate the length of the nonglacial interval in the St. Lawrence lowland is admittedly precarious, but, judging by the findings of Zumberge and Potzger (*5*), it is probable that the peat alone represents a period of 3000 to 4000 yr. Some 500 to 700 yr are represented by the varved clays, both above and below the nonglacial deposits. The period of erosion, previous to deposition of the nonglacial deposits, is of undetermined length, but it is probable that only 2000 to 3000 yr are represented by this hiatus; otherwise, evidence should have been found of a type of vegetation more closely resembling that of the present. It is likely that there was not enough time available for migration of hemlock into the St. Lawrence lowland during the nonglacial interval, which was named the St. Pierre interval by Gadd (*3*).

The chronologic position of the St. Pierre interval is still subject to some doubt. It is older than any of the recognized intervals of the Wisconsin stage.

Correlation with the Sangamon interglacial meets with several difficulties: cool climatic conditions apparently prevailed throughout the St. Pierre interval. The length of the interval was certainly much shorter than that suggested for Sangamon time (about 100,000 years). For many reasons, it appears from the chronologic point of view that the St. Pierre interval is pre-Wisconsin but post-Sangamon in age. Flint's suggestive speculation (*4*, pp. 284–285) about a possible pre-Wisconsin but post-Sangamon glaciation and an interglacial period deserves mention. Although the present study lends support to Flint's hypothesis, another explanation seems more natural. The advance of the Wisconsin ice, like the recessional process, was not a continuous process but probably was also comprised of several glacial stages separated by nonglacial periods, some of considerable magnitude. It is quite possible that one of these fluctuations is represented by the St. Pierre interval. During the early stages of glaciation, no appreciable depression of the earth's crust (owing to the weight of the ice) would have occurred, and this may well account for the absence of a marine invasion of the St. Lawrence lowland at the beginning of the St. Pierre interval. This concept is also in accord with the stratigraphic observations made in the James Bay lowland. The St. Pierre interval seems to be a correlative of that represented by the nonglacial deposits along the Missinaibi River.

The facts at hand are insufficient to establish a revised chronology of late Pleistocene time in eastern North America.

JAAN TERASMAE
Geological Survey of Canada, Ottawa, Ontario

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1. This article is published with the permission of the Deputy Minister, Department of Mines and Technical Surveys, Ottawa, Canada.
2. M. Y. Williams, *Geol. Survey Canada Summary Rept. 1920* (1921), part D, p. 24; F. H. McLearn, *Geol. Survey Canada Summary Rept. 1926* (1927), part C, pp. 16–47.
3. N. R. Gadd, Ph.D. thesis, department of geology, University of Illinois (1955).
4. R. F. Flint, *Am. J. Sci.* 254, 265 (1956).
5. J. H. Zumberge and J. E. Potzger, *Bull. Geol. Soc. Amer.* 67, 271 (1956).

6 March 1957

Insect Spiracle as an Independent Effector

Recent studies of the spiracular control of discontinuous respiration in pupal silkworms have shown that the muscle serving the spiracle of *Hyalophora cecropia* is physiologically very different from any muscle heretofore encountered in insects (*1*), a fact confirmed by Case for the cockroach (*2*). The peculiar behavior of the spiracular muscle confers on the spiracular apparatus certain novel properties which are the subject of this report (*3*).

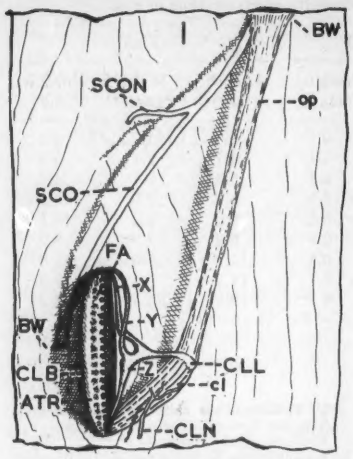

Fig. 1. Pupal spiracular regulatory apparatus as seen from inside the animal. No tracheae are shown. *ATR*, atrium; *BW*, body wall; *cl*, closer muscle; *CLB*, closing bow; *CLL*, closing lever; *CLN*, nerve of closer muscle; *FA*, filter apparatus; *op*, elastic opener; *SCO*, scolopophorous organ; *SCON*, nerve of scolopophorous organ; *X*, dorsolateral closing bar; *Y*, dorsomedian closing bar; *Z*, ventral closing bar.

The aperture of each of the 14 spiracles of a *cecropia* pupa is regulated by a valve. This valve is attached to a chitinous frame consisting of three bars, a bow, and a lever, and is moved by a single closer muscle (Fig. 1). When the muscle relaxes, the elasticity of the chitinous frame and the tension of an elastic ligament which opposes the closer muscle cause the valve to open. The muscle is apparently innervated solely by a nerve from the corresponding segmental ganglion and by a branch of the median nerve of the previous segment. Careful staining of more than 200 preparations with methylene blue and with the silver techniques of Palmgren (*4*) and Golgi (*5*) have failed to reveal nerve cell bodies imbedded in or near the muscle—that is, there is no peripheral ganglion. Histologically, the muscle itself revealed typical striations, a tremendous number of Doyere's cones, and a nerve fiber running under the sarcolemma (Fig. 2).

In the intact insect, so far as we can judge, all the spiracles open and close more or less in unison because of the synchronous relaxing of the closer muscles. When the central nerve cord was transected at any level, the spiracles anterior to the cut remained in synchrony with one another, while those posterior to the cut were also synchronous but independent of the anterior set. The central nervous system thus coordinates the spiracles. However, no coordinating center could be found in either the abdomen, thorax, or head, for no group of ganglia was indispensable for coordination. When a segmental ganglion was removed, thus denervating the corresponding spiracular muscle, the muscle remained contracted for more than 90 days, with an occasional uncoordinated opening. The muscle could be induced to relax by exposure to high carbon dioxide or low oxygen tensions, but it contracted again upon return to air. The stimulus for contraction of the closer muscle after it had been deprived of all connections to the central nervous system was not at all apparent, and to clarify this issue we compared closely the behavior of innervated and denervated muscles.

We began by severing the nerve leading from the central nervous system to a single spiracle through carefully placed incisions in the body wall, either close to the abdominal ganglion or close to the spiracular muscle. Spiracles denervated at either site behaved substantially the same, being somewhat less sensitive to carbon dioxide and oxygen than innervated spiracles. We next cut both the scolopophorous organ and the elastic opener (Fig. 1). This failed to interfere with either the coordinated activity of a normal spiracle or the autonomous activity of a denervated spiracle, and thus these two structures appear to play no indispensable role in spiracular activity. This was borne out in experiments with isolated spiracles and bisected pupae.

Spiracles were isolated with only a surround of pupal cuticle supporting the spiracular regulatory apparatus and placed on filter paper moistened with

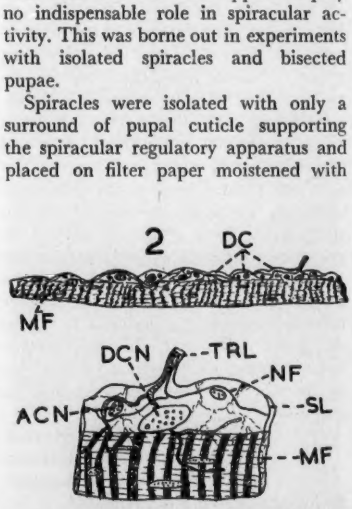

Fig. 2. (Top) Single muscle fiber from a pupal spiracular closer muscle, showing the numerous Doyere's cones (× 40). (Bottom) Enlargement of a piece of the muscle fiber to show details within one cone. *ACN*, accessory nucleus; *DC*, Doyere's cones; *DCN*, Doyere's cone nucleus; *MF*, muscle fiber; *NF*, nerve fiber; *SL*, sarcolemma; *TRL*, tracheole.

insect Ringer's solution in a glass chamber. When carbon dioxide was added, the isolated spiracles opened; when oxygen was added, they closed. That is, the isolated spiracles behaved in relatively normal fashion for many hours as independent effectors. In hanging drops of a suitable medium (*6*), they functioned for as long as 3 days.

Further experiments were performed on pupae bisected parasagitally in Ringer's solution so that one side had spiracles with intact connections to the central nervous system, while the other side had no connections to the central nervous system. When a stream of carbon dioxide was directed at a spiracle, it opened; when oxygen was applied, it closed. This was true both of spiracles connected to the central nervous system and of those not connected to it.

To see whether carbon dioxide was acting by virtue of its acidity, Ringer's solutions of different *p*H were added to the spiracle. When a spiracle was flooded with Ringer's solution of *p*H 5 or less, it opened; when basic Ringer's of *p*H 9 was added, it closed. Ringer's of intermediate *p*H gave variable results. Both innervated and denervated spiracles responded similarly to changes in *p*H. The *p*H's to which the spiracle responded were extreme compared with the normal *p*H variations expected in the insect. Therefore, it is unlikely that carbon dioxide is acting as an acid. Further evidence that *p*H does not serve as the normal stimulus for the spiracles stems from the fact that spiracles placed in a phosphate buffer at *p*H 7 continued to respond to both carbon dioxide and oxygen.

In all these experiments, the "receptors" sensitive to changes in gas and acidity appeared to be localized only in the region of the spiracle, for when these agents were applied locally to other parts of the pupa, particularly to parts of the central nervous system, the spiracles failed to respond.

The specific function of each part of the spiracular apparatus was studied in preparations in Ringer's solution. Parts of the apparatus were excised individually or in combinations, and the spiracle was stimulated. These experiments revealed that when the spiracular nerve was cut as close to the muscle as possible and the nerve stump carefully dissected out of the muscle, and when all the parts of the apparatus were removed except the naked bars, lever, and closer muscle, the muscle still responded to carbon dioxide and oxygen. It is clear that the autonomy of the spiracle is a function of the closer muscle: the muscle remains contracted without stimulation of the central nervous system, not for hours but for months. Furthermore, since repeated histological study has failed to reveal ganglion cells in or near the muscle, we must conclude that this muscle can contract without any nervous stimulation whatever—that is, the spiracle muscle is spontaneously excitable. This spontaneous excitability is reflected in electric recordings which showed that the denervated muscle continued to produce action potentials. Indeed, even when most of the muscle fibers were cut away, the few remaining fibers continued to produce rhythmic action potentials at a rate of 12 to 15 per second (*7*). In the intact insect, of course, the spiracular muscle is normally controlled by the central nervous system.

From these experiments we have concluded that, while the spiracles are normally coordinated by the central nervous system, they can behave like independent effectors sensitive to carbon dioxide and to oxygen. In the normal as well as in the denervated condition, the receptor mechanism sensitive to these gases seems to be located within the muscle itself. The spiracular muscle, so far as we are aware, is unique among insects and probably among higher animals in exhibiting sustained contractions in the apparent absence of nervous stimulation.

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24 February 1957

New Pharmacoconvulsive Agent

In our investigations concerning the anesthetic action of aliphatic fluorinated ethers of low molecular weight (*1*) the anesthetic properties of Fluoromar (R) (trifluoroethyl vinyl ether) were observed. These appeared sufficiently promising to warrant a study of its effect on man (*2*). Further observations among these compounds revealed that perfluorodiethyl ether was devoid of anesthetic activity. On the other hand, hexafluorodiethyl ether ($CF_3CH_2—O—CH_2CF_3$) was found to elicit violent convulsions upon inhalation in many species of laboratory animals.

Hexafluorodiethyl ether is a colorless mobile liquid which emits a mild, pleasant ethereal odor. Its boiling point is 63.9°C, and its specific gravity is $1.41\frac{20°}{4°}$. It is very insoluble in water but soluble in alcohol.

White rats that were exposed to the vapor of hexafluorodiethyl ether in concentrations as low as 30 ppm (wt/vol.) convulsed violently within 30 seconds. There were marked clonic and tonic seizures, and there was some degree of emprosthotonus. The convulsions stopped promptly when the agent was removed from the inspired air. Repeated exposures on subsequent days did not appear to produce injury to the animals, as shown by studies of blood chemistry and by histological examination of the lungs, brain, liver, kidneys, and bone marrow.

The convulsive seizure is readily prevented in the rat, dog, and monkey by Pentothal Sodium, ether, or Fluoromar anesthesia, but not by mephenesin. Under Pentothal anesthesia, hexafluorodiethyl ether caused no change in the pattern of the electrocardiogram and only a slight depression in blood pressure and a mild tachycardia in dogs during the cortical dysrhythmia.

The compound did not produce hypoglycemia in the rabbit. Studies in dogs demonstrated that it did not inactivate cholinesterase.

Electroencephalographic studies in dogs and monkeys under succinylcholine-Pentothal Sodium anesthesia were performed. The inhalation of hexafluorodiethyl ether produced marked cortical dysrhythmia without involvement of the skeletal muscle. The multiple spike and three- to four-per-second slow-wave discharge which first occurs was soon followed by high-voltage multiple spiking similar to that of the myoclonic type *petit mal* epilepsy and to the cerebral pattern elicited by Metrazol injections.

We considered the agent as possibly useful as a pharmacoconvulsive drug for shock therapy in mentally disturbed patients. Among the factors which suggested its use were the apparent harmless nature of repeated exposures to animals, the rapid onset of the seizures, the ease of control of depth and duration of the seizures, and the similarity of the cortical dysrhythmia to that evoked by Metrazol. Accordingly, four patients who were suffering with mental disturbances in which electroshock therapy was indicated were subjected to inhalation of hexafluorodiethyl ether. The agent was placed in a plastic inhaler dispersed on cotton. The inhaler was of the type em-

ployed for the administration of the generally used nasal decongestants. Volumes of 1 to 3 ml were employed. The patients were not anesthetized, and the inhaler was placed in one of the nostrils. Within 1 to 3 minutes, the convulsive seizure ensued and continued from 2 to 4 minutes until the inhaler was withdrawn. The seizure episode resembled that of electroshock therapy. Unconsciousness supervened following the convulsion for from 5 to 17 minutes in three patients. The first patient was allowed to inhale the compound only until a few myoclonic facial twitches occurred.

The four patients recovered uneventfully. There appeared to be no clouding of memory. Two of the patients who were combative assumed a more cooperative attitude.

It is possible that this comparatively simple procedure of the inhalation of hexafluorodiethyl ether might be found useful in the treatment of certain types of mentally ill patients.

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24 May 1957

Combination of Characters (Drug Resistance) in a Single Strain of Psittacosis Virus

The susceptibility of psittacosis virus and other viruses of the same group to chemotherapeutic drugs and the existence of several stable, drug-resistant strains provide valuable tools for genetic studies in this group of viruses. The experiments reported here were performed with two strains of psittacosis virus, one resistant to sulfonamides (*1*), strain Sa-r, and the other resistant to chlortetracycline (*2*), strain Ctc-r. When strain Ctc-r is introduced into the yolk sac of 7- or 8-day embryonated eggs in standard doses, it multiplies in the presence of 0.15- to 0.5-mg doses of chlortetracycline given via the air sac (*3*) essentially as well as in the absence of the drug and kills the embryo on the 4th day or later, depending on the dosage. Sulfadiazine, in amounts of 1.5 to 5.0 mg administered in similar fashion, will completely protect the inoculated embryos from death for the usual 10-day observation period. The converse is true of strain Sa-r, since it is susceptible to the antiviral action of chlortetracycline but possesses a high degree of resistance to sulfadiazine. These facts are illustrated in egg groups A, B, and C of experiments 1 and 2, Fig. 1. The failure of chlortetracycline to overcome completely the infection with strain Sa-r (experiment 2, group B) is due to the very heavy dose of virus (5 percent) used in this particular experiment.

When strains Ctc-r and Sa-r were grown together in the yolk sac of embryonated eggs, substrains were repeatedly isolated that possessed resistance to both drugs. One such experiment, No. 3 (Fig. 1), was chosen as an illustration because of its conciseness. This experiment was performed by mixing equal parts of 5-percent emulsions of the two strains and injecting them into the yolk sacs of four groups of eggs that received drugs as indicated in Fig. 1. The results in groups A, B, and C were as expected, since both strains would multiply in group A, strain Ctc-r in group B, and strain Sa-r in group C eggs. Virus growth, as determined by embryo deaths, was almost completely suppressed or delayed in group D for the first 7 days of observation. This also was expected because, in this group, each virus of the mixture would encounter a drug to which it is susceptible. However, on the eighth, ninth, and tenth days, 11 deaths occurred in the 13 embryos remaining. When yolk sacs harvested from the three embryos that died on the ninth day were used individually for inoculation of eggs in experiments of the same design as experiment 3 (but not shown in Fig. 1), all deaths in double drug groups (D) occurred before the seventh day, indicating that the material passed possessed resistance to both drugs. Three other experiments similar to No. 3 have been performed, and in each case harvests of individual eggs (total, 18) have possessed levels of resistance to both drugs similar to those seen individually in the original strains.

As is indicated in Fig. 1, harvests were also made from embryos of groups D in control experiments 1 and 2. These were tested in the same manner as described

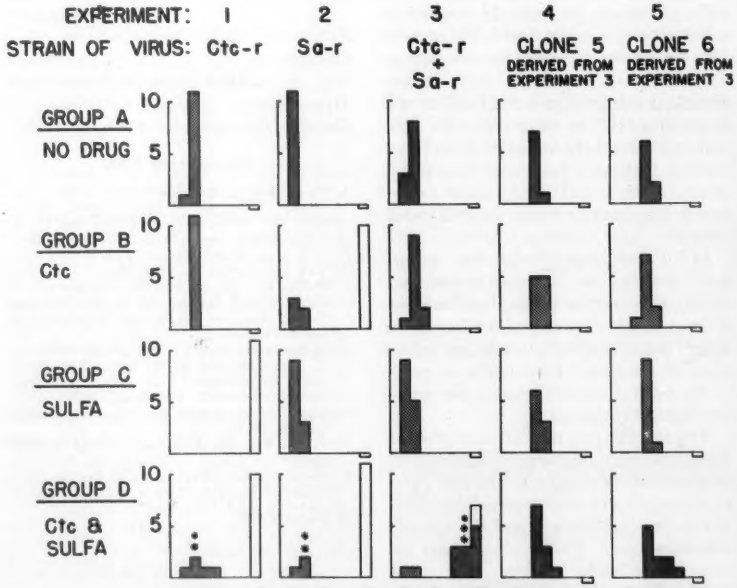
EXPERIMENT: 1 2 3 4 5
STRAIN OF VIRUS: Ctc-r Sa-r Ctc-r + Sa-r CLONE 5 DERIVED FROM EXPERIMENT 3 CLONE 6 DERIVED FROM EXPERIMENT 3
GROUP A
NO DRUG
GROUP B
Ctc
GROUP C
SULFA
GROUP D
Ctc & SULFA
10
5
3 6 10 3 6 10 3 6 10 3 6 10 3 6 10
DAYS AFTER INOCULATION

Fig. 1. Effect of chlortetracycline (Ctc) and sulfadiazine on infection of chick embryos with drug-resistant strains of psittacosis virus. The shaded bars represent deaths of chick embryos on the days indicated on the abscissa, and in the numbers indicated on the ordinate. Nonspecific deaths in the first 2 days are omitted. Open bars represent embryos surviving on the tenth day; where there were no survivors, a short bar is placed below the abscissa. Virus dosage: 0.25 ml of 5-percent emulsion in experiments 1, 2, and 3; 0.1 percent in experiments 4 and 5. Drug dosage: 0.5 mg of chlortetracycline and 5.0 mg of sulfadiazine on days 0, 2, and 4 in experiments 1, 2, and 3; 0.3 and 1.5 mg, respectively, on days 1 and 3 in experiments 4 and 5. Asterisks represent yolk sacs harvested on day indicated and subjected to further tests (see text).

for the harvests of experiment 3. Failure to recover virus in one case and evidence of low titer in two others suggest that these deaths may have been caused by the toxicity of the drugs used in this dosage, as was seen occasionally in drug controls of experiments not illustrated here. As was expected, the isolates were found to possess unchanged the drug resistance and susceptibility of the strain used in the experiment from which they were harvested.

Six infected yolk sacs, harvested from group-D eggs of experiment 3 and others, have been subjected individually to two serial "limit dilution" (*4*) passages in an attempt to provide clones of virus. The method was satisfactory in most instances, allowing passages to be made from individual eggs in which the probability was high that infection had occurred from a single infecting dose (one to four infected eggs in a group of ten or more, *5*). Since the assumption is valid that a single morphological unit of the virus (elementary body) represents a single infecting dose (*6*), the probability is good that actual clones were produced, and ten such preparations have been so named. Tests with two of them, derived from the harvests of experiment 3, are depicted as experiments 4 and 5 in Fig. 1. The dosages of virus and of drugs were reduced in these tests to avoid toxic deaths, but the results were essentially the same as those seen with previously used heavier doses and indicate resistance to both drugs.

Several hypotheses have been entertained during the course of this work to explain the results obtained. The possibility of a rapid mutation of one of the strains to the additional drug resistance had to be considered. This seems improbable in view of the absence of any evidence for such a mutation in experiments 1 and 2 and in additional similar tests not illustrated. The gradual acquisition of drug resistance previously observed during serial passages of single strains in the presence of drug (see *2*) would also render this explanation unlikely. Furthermore, mixed cultures of a drug-resistant and a drug-susceptible strain have not yielded evidence for mutation to a second drug resistance. The occurrence of a synergistic action, in terms of drug resistance, when the two strains were grown together was also considered. However, experiment 3 and others show that, when the two strains are placed together, double drug resistance is not seen immediately, as is the case with the isolates that possess the two characters, as illustrated in experiments 4 and 5. Furthermore, the fact that resistance to both drugs has been easily demonstrated in all ten isolates that had been passed at high dilutions under conditions favorable for the isolation of clones renders untenable any hypothesis involving persistence of both strains as separate entities.

Thus we are left with the evidence strongly favoring a combination of the two characters of drug resistance in a single strain as the correct interpretation of these results. We are deliberately using the word *combination* in a nontechnical sense while work is in progress to analyze this phenomenon and identify it in genetic terms (*7*).

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24 May 1957

A^{40}/K^{40} Ages of Micas and Feldspars from the Glenarm Series near Baltimore, Maryland

The inner zone of the central Appalachian Mountains is a belt of metamorphic and plutonic rocks which crop out in the Blue Ridge province and underlie most of the Piedmont province. In southeastern Pennsylvania and adjacent parts of Maryland, the oldest rock is the Baltimore gneiss, which forms domical uplifts surrounded and overlain by the Glenarm series. This series consists of a basal quartzite (Setters) overlain by a marble (Cockeysville) and a thick series of mica schists (Wissahickon and Peters Creek) of sedimentary origin but including in some places altered volcanics (*1*). The Glenarm group is locally cut by pegmatite, granite, and other plutonic rocks.

The age of the Glenarm series is not known; it is generally assigned to the pre-Cambrian (*2*), although some workers have considered it a eugeosynclinal facies of the older Paleozoic (*3*). The age of the Glenarm series is fundamental for the interpretation of the width and depth of the Appalachian geosyncline, its deformation, the participation of the basement in the deformation, and the role played by the intrusions. Here and there, younger slates are infolded in the Glenarm series (*4*). These have yielded late Ordovician fossils in the Quantico and Arvonia areas of Virginia, where they apparently lie unconformably on the metamorphic rocks and the granites which intrude them. The Glenarm rocks, proper, have yielded no fossils.

Despite detailed field and laboratory studies over a period of 50 years, the age of the Glenarm schists remains uncertain. It seemed appropriate, therefore, to determine the age of the minerals within the Glenarm rocks and their cross-cutting pegmatites (*5*). To this end, micas were collected from the Setters and Cockeysville formations, and feldspar and mica were collected from the cross-cutting pegmatites. Because the pegmatites postdate the Glenarm rocks, a dating of their mica or feldspar would establish a minimum age for the series near Baltimore. The age of the micas within the Glenarm rocks would establish the age of the metamorphism.

The age of a sample is given by the expression

$$t = \frac{1}{\lambda} \ln \left[1 + \frac{A^{40}}{K^{40}} \frac{(R+1)}{R} \right]$$

where

$$\lambda = \lambda_e + \lambda_\beta$$

and

$$R = \lambda_e / \lambda_\beta$$

λ_e and λ_β being the decay constants for electron capture and beta decay, respectively; A^{40}/K^{40} is the ratio of the number of radiogenic argon-40 atoms to the number of potassium-40 atoms now present in the sample; and t is the age in years.

Uncertainty in the values of λ_e and λ_β has to some extent limited the application of the method in solving geologic problems. It has been proposed (*6*, *7*) that the value of R is 0.085, assuming that $\lambda = 0.55 \times 10^{-9}$ yr^{-1}. These values for the constants R and λ are hereafter referred to as "decay constants I." This value for R was obtained by determining the A^{40}/K^{40} ratios in feldspars of known age. Subsequent work by Wetherill (*8*) has shown that the feldspars have lost radiogenic argon in comparison to micas and hence that decay constants I are empirical calibration constants which correct for argon loss from the feldspars investigated (*9*). In a recent paper by Wetherill *et al.* (*10*), it is shown that $\lambda_e = 0.0557 \times 10^{-9}$ yr^{-1} and that $R = 0.118$, assuming that $\lambda_\beta = 0.472 \times 10^{-9}$ yr^{-1}. The constants $R = 0.118$ and $\lambda = 0.528 \times 10^{-9}$ yr^{-1} are hereafter referred to as "decay constants II." These constants (II) are in reasonable agreement with those determined by counting methods.

The samples utilized, and the localities

from which they were collected, are presented in column 1 of Table 1. Samples PE-2, PE-3 and PE-4 are fresh microclines. Sample PEM-1 is from very large sheets of muscovite. All of the aforementioned samples were taken from pegmatites which were observed to cross-cut rocks of the Glenarm series.

Samples PEM-2 and PEM-2-f2 are both muscovites taken from the Setters quartzite. The first of these was taken from small pegmatitic blebs, about 1 inch in size, included in the quartzite. The second sample was extracted from the quartzite proper and is mica which was oriented parallel to the foliation and which appeared to be concentrated at the free surfaces of these structures.

Sample PEM 3-1 is a phlogopite which was extracted from the Cockeysville marble. This phlogopite occurs in somewhat concentrated patches and as more sparsely disseminated grains throughout the marble at the Arundel Quarry.

Sample BGBi-1 is a fresh biotite extracted from the Baltimore gneiss. This biotite was an integral part of the gneissic texture of the Baltimore gneiss. The age obtained was 319 million years. This result indicates that the period of metamorphism during which the gneissic texture was developed in the rock of the Towson dome was contemporaneous with the metamorphism of the Glenarm series. This date is in disagreement with the pre-Cambrian age usually assigned to the Baltimore gneiss.

The results obtained for these materials are presented in Table 1. Column 3 gives the radiogenic A^{40} in cubic centimeters (S.T.P.) per gram. In all the experiments reported, the argon extracted was more than 90 percent radiogenic. The isotopic analyses were made in J. H. Reynolds' laboratory at Berkeley, California. The techniques used in the A^{40}/K^{40} age determinations have been described in an earlier publication (*6*). All the argon extractions reported in Table 1 were done using NaOH flux. Argon was also extracted from samples BGBi-1 and PEM-1 by induction heating of the samples to 1500°C in a molybdenum crucible without any flux. The radiogenic argon yields were respectively 0.954×10^{-4} and 1.37×10^{-4} cm³ (S.T.P.) per gram. A comparison of these data with the results obtained with NaOH flux as presented in Table 1 shows that the two extraction procedures give results in good agreement.

In column 5, the ages t_I of the microclines are given. These ages were calculated using decay constants I, which correct for argon loss from the feldspars. In column 6 are tabulated the ages t_{II} of the micas. These ages were calculated using the absolute decay constants II.

The results obtained are in reasonably good agreement. The age of sample PEM-2-f2 is obviously low. The total spread of ages indicated is 20 percent. This is much greater than the analytic error of the A^{40}/K^{40} determinations. In this study it is clear that the A^{40}/K^{40} method does not "resolve" the more refined sequential relationships in conformance with the known relative ages of the metamorphics and cross-cutting pegmatites.

From the preceding data, it is concluded that both the age of metamorphism of the Glenarm series and the time of pegmatite injection was about 350 million years ago, corresponding to the end of the Ordovician period on the Holmes time scale. The absolute age is thus seen to coincide with the ages of pegmatites in New England and North Carolina. This evidence supports the view that the whole eastern Appalachian region was "simultaneously" subject to vigorous igneous and metamorphic activity about 350 ± 20 million years ago.

The thesis that the Glenarm series is pre-Cambrian because of its degree of metamorphism is untenable on the basis of the data presented here. These A^{40}/K^{40} dates do not, however, preclude the possibility that this series was originally deposited during pre-Cambrian time.

The general agreement obtained on materials from such contrasting lithologies as the Cockeysville marble, the Setters quartzite, and the cross-cutting pegmatites indicates that it is sometimes possible to determine the ages of micas formed during profound metamorphic episodes. Such micas do not appear to show any effect of inheritance of argon.

Table 1. A^{40}/K^{40} ages of samples.

Sample and Locality	K (%)	Radiogenic $A^{40} \times 10^4$ cm³ (S.T.P.)/g	A^{40}/K^{40}	Age (10^6 yr) $t_I \times 10^{-6}$	$t_{II} \times 10^{-6}$
PE-2 Microcline. Pegmatite, Notch Cliff crossing of Maryland and Pennsylvania Railroad 2 mi southwest of Glenarm, Md.	11.25	1.25	0.0163	344	
PE-3 Microcline. Pegmatite, Glenarm Road 0.4 mi northeast of intersection with Cromwell Bridge Road	10.85	1.22	0.0165	347	
PE-4 Microcline. Pegmatite, 0.7 mi south of Henryton, near Henryton Road	11.22	1.34	0.0175	367	
PEM-2 Muscovite. Pegmatite blebs in Setters quartzite from rustic quarry near Cromwell Bridge Road 3.5 mi northeast of Towson, Md.	8.50	1.19	0.0206		338
PEM-2-f2 Muscovite. Setters quartzite from same location as sample PEM-2	8.36	1.06	0.0186		309
PEM-1 Muscovite. Pegmatite on Baltimore and Ohio Railroad tracks about 0.3 mi east of Daniels, Md.	8.60	1.34	0.0229		372
PEM-3-1 Phlogopite. Cockeysville marble from Arundel Corporation Quarry 2.5 mi west of Lake Roland	8.51	1.14	0.0196		324
BGBi-1 Biotite. Baltimore gneiss from road cut, Charles Street Ave., Towson, Md., between Malvern Ave. and Chesapeake Ave.	7.24	0.951	0.0193		319

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13 May 1957

Some Histochemical Observations on Human Dystrophic Muscle

A number of histochemical techniques have been applied to biopsy specimens of human muscle taken from 32 patients suffering from muscular dystrophies and a variety of other muscular diseases. Control muscle was obtained partly by biopsy, at post mortem, and within 1 hour of death from two young, healthy men.

The following histochemical tests were employed: succinic dehydrogenase, cytochrome oxidase, cholinesterase, 5-nucleotidase, acid and alkaline phosphatase, Periodic acid-Schiff reaction, fat, disulfide and sulfhydryl groups, and amino groups. Figure 1 shows some of the results.

Succinic dehydrogenase activity varied considerably between different control muscles and between individual fibers in any one muscle. It varied independently of the cytochrome oxidase reaction. In pathological muscle there was a decrease in activity of succinic dehydrogenase, suggesting a lowered aerobic metabolism. Where substantial replacement of muscle by connective tissue occurred, there was, as might be expected, a considerable reduction of the over-all reaction for this enzyme.

Gomori's (*1*) modification of Koelle and Friedenwald's (*2*) method showed, both in control and in pathological muscle, positive classical end-plates, "terminaisons en plaque" (*3*), and the elongated scattered type of end-plate described by Coërs as "terminaisons en grappe." We were also able to confirm the findings by Couteaux in 1953 and Gerebtzoff in 1956 (quoted by Gerebtzoff, *4*) that there were cholinesterase-positive reticulated or parallel-guttered structures sitting like caps over the ends of the muscle fibers—that is, at the musculotendinous junctions. Another cholinesterase-positive structure consisted of a series of parallel gutters situated in various positions along the length of the muscle fibers. We call these "cake-frill" endings. Their appearance suggests that they, like the endings of the musculotendinous junctions, are stretch receptors. Muscle spindles gave a positive reaction, mainly in the end-plates situated at the poles of the spindles, but occasionally also in some of the spirally arranged sensory nerve fibers.

There was very little evidence of decrease of cholinesterase activity in dystrophic muscle, but where there was considerable replacement of muscle by connective tissue, as for example in facioscapulohumeral or familial dystrophy, isolated and apparently intact end-plates attached to remnants of muscle fibers were seen which gave a normal cholinesterase reaction. Atrophying muscle fibers showed a strong positive reaction in the muscle substance itself.

We could obtain little evidence from our work that muscular dystrophy and related diseases were associated with either physical or enzymatic breakdown of neuromuscular transmission.

Nerves and some blood vessels are the only positive elements in normal human muscle. In dystrophies characterized by atrophy of muscle fibers and their replacement by connective tissue, cells, fibers, and capillaries of the latter gave a strong 5-nucleotidase reaction and appeared to be actively invading and destroying the substance of the muscle fibers. Atrophying fibers also gave a strong reaction for the enzyme.

Since 5-nucleotidase dephosphorylates adenosine monophosphate (which is a starting point for the resynthesis of adenosine triphosphate), this result may be of some significance. Inhibitors of 5-nucleotidase may be of use in the treatment of these conditions, and so might also the anti-snake-venom serums prepared from venoms containing 5-nucleotidase.

Acid phosphatase in normal muscle is present in peripheral nerves, Golgi material and nuclei of both muscle fibers and connective tissue cells, and in adipose tissue. The small amount of acid phos-

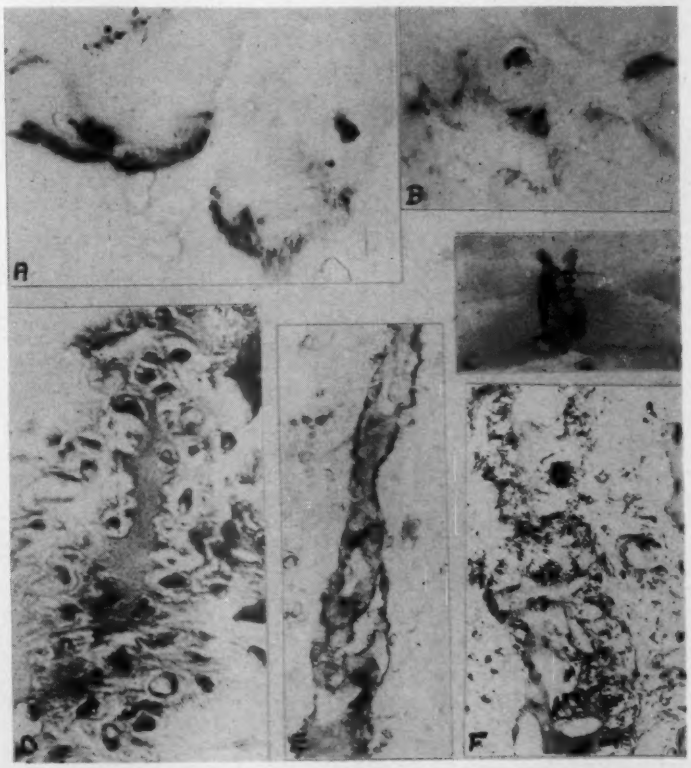

Fig. 1. *A*, Acetyl cholinesterase in structures situated at musculotendinous junctions; *B*, acetyl cholinesterase in numerous small end-plates from a case of dystrophia myotonica; *C*, acetyl cholinesterase in two "cake-frill" type structures in adjacent muscle fibers; *D*, 5-nucleotidase in an atrophied degenerating fiber and in the cells involved in its destruction, from a case of doubtful diagnosis (polymyositis or pseudohypertrophic muscular dystrophy); *E*, alkaline phosphatase in a degenerating muscle fiber and in fine connective tissue fibers wound around it, from a case of familial dystrophy; *F*, acid phosphatase present in high concentration in a muscle fiber undergoing necrosis and in the cells involved in this necrosis (the muscle was taken from a case of familial dystrophy).

phatase in the substance of the muscle fibers is increased in atrophied fibers. Where muscle fibers are being replaced by connective tissue, the invading cells show a high level of acid phosphatase activity.

Alkaline phosphatase in normal human muscle is limited to the capillaries and the intima of larger vessels. In dystrophies, the enzyme occasionally appears in the atrophying muscle fibers and in the very fine connective tissue fibers found surrounding them.

The increase of phosphatase activity (including 5-nucleotidase) in the connective tissue of muscles in some types of dystrophy suggests that phosphatases may play an important part in the destruction of muscle fibers associated with these diseases. Even if they are not directly concerned with the breakdown of muscle substance, they may cause functional failure through excessive breakdown of high-energy phosphate compounds. A similar process may be involved in aging (*5*).

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6 May 1957

Resistance to Desiccation in Intertidal Barnacles

The resistance to desiccation on exposure to air is recognized to be an important factor in the zonation of intertidal animals, and it is achieved in a variety of ways by different species. In spite of the work of Monterosso (*1*) on *Chthamalus stellatus* var. *depressus*, it is frequently stated that barnacles that live relatively high up on the shore achieve their resistance to desiccation by enclosing a small quantity of water in the mantle cavity as the tide recedes. This is not so.

Although morphologically they are very similar, littoral and sublittoral barnacles behave very differently when they are removed from water. In general, the intertidal species such as *Chthamalus stellatus, C. fragilis, C. dalli, Balanus balanoides* and *B. glandula* show what may be termed a "controlled" behavior pattern that leads to adjustment to the new environment. On the other hand, sublittoral species such as *Balanus crenatus* or *B. balanus* struggle in an erratic fashion and soon become desiccated.

The most detailed observations have been made on the intertidal *B. balanoides*. When these are first removed from water, the cirri, in a collapsed state, are partially extruded several times, from the mantle cavity with the expulsion of water. Such movements are repeated at intervals during the first few minutes of exposure to air. Very soon this activity decreases. The valves, still far from being fully retracted, then come together in such a way that the underlying, uncalcified folds of the operculum form a small, diamond-shaped, micropylarlike opening. There is, therefore, direct access for air to the mantle cavity.

Subsequent macroscopic movements of the valves may be accompanied by further expulsion of small droplets of water; such droplets are often found on the valves of shore animals during intertidal periods. In between such macroscopic movements, and subsequent to them, the micropylar orifice is open and, from time to time, appears to be subject to regular pulsation—some 40 pulsations per minute. After several hours the valves may completely close from time to time; this is accompanied by reformation of the micropylar opening, whose size decreases with time. Over a period of 24 hours the valves are not fully retracted within the shell; complete retraction takes place only when the valves are touched (this is doubtless a defense mechanism against predators, which usually attack the animal at the opercular valves).

Although extremes of desiccation attributable to high temperature or long exposure to air may result in complete closure, the evidence indicates that, during an intertidal period of several hours, the barnacles are utilizing atmospheric oxygen in their respiratory activity. That this is the case is also supported by the fact that we have found that, after the barnacles have been exposed to air for several hours, there is no significant accumulation of lactic acid and no accumulated oxygen debt such as might be expected if anaerobic processes were involved.

When animals, after exposure to air for some time, are reimmersed, the operculum is quickly opened (in *B. balanoides*, this occurs within from 10 to 15 seconds), and bubbles of gas escape from the mantle cavity. This precedes extrusion of the cirri, amongst which gas bubbles are often entangled, and resumption of normal cirral activity (*2*).

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2 May 1957

Adsorption-Hemagglutination Test for Influenza Virus in Monkey Kidney Tissue Culture

In the course of investigations of influenza viruses in monkey kidney tissue culture, it was observed that addition of erythrocytes directly to tubes with viral cytopathic effect resulted in adsorption of erythrocytes onto the monocellular epithelial sheet. Further studies indicated that this is a specific phenomenon dependent on the hemagglutinating property of the virus. Besides contributing to clearer understanding of the mechanism of hemagglutination, the reaction may be of practical importance in diagnostic work. The purpose of this preliminary report is to describe our technique because of its possible value to rapid diagnosis of suspected cases of influenza. This is pertinent to studies of the influenza epidemic which has already involved major portions of the Far East.

Monkey kidney cells in monolayer sheets were prepared by a modified Youngner technique (*1*), grown in a medium recommended by Melnick (*2*), and maintained in a nutrient mixture (*3*) of 75 per cent Earle's balanced salt solution, 24 percent bovine serum ultrafiltrate, and 1 percent heated horse serum with appropriate antibiotics. Calf serum was not used in the maintenance medium because of its possible anti-viral effect. Most of the experiments employed an influenza virus strain recently isolated in this laboratory directly in tissue culture; this strain was provisionally designated A/Md/1542/57 and was found to be closely related to A/Md/1/55.

Our current technique is as follows. Supernatant fluids are removed from infected and control monkey kidney tubes. Two-tenths of a milliliter of 0.4-percent suspension of washed, citrated guinea pig erythrocytes are added to each tube (results with influenza A were not as consistent using chicken erythrocytes). The tubes are placed in horizontal position for about 1 minute, and the initial reading is made by microscopic examination under low power for clumping of erythrocytes in the fluid and visible adsorption-hemagglutination. With experience, this examination is often sufficient to determine whether the test is positive or negative. Because the settling of erythrocytes onto the monolayer sheet during standing, especially if it exceeds a period of a few minutes, may resemble a

positive reaction, it is generally advisable to wash the tubes with 1 ml of Earle's balanced salt solution or maintenance medium after the preliminary reading and replace the discarded fluid. This removes most of the unadsorbed erythrocytes, leaving a clearly visible monkey kidney cell sheet studded with clumps of agglutinated red blood cells adhering to the tissue in an easily recognizable characteristic pattern.

Figure 1*a* shows such a positive reaction 4 days after inoculation of the tube with a strain of influenza A virus. For comparison, photographs of a similarly treated uninoculated tube of the same age (Fig. 1*b*) and an untreated but virus-inoculated tube (Fig. 1*c*) are also included. Only a few floating erythrocytes against the background of healthy cells are seen in the normal control, while the infected tube shows typical cytopathic effect observed prior to addition of red blood cells.

Inasmuch as the readability of the adsorption-hemagglutination test depends on the presence of an adequate area of monolayer cell sheet, the test should be performed before the cell culture is destroyed either by far advanced cytopathic effect or by degenerative changes caused by aging. At first monkey kidney tubes were always tested for adsorption-hemagglutination after specific cellular degeneration was observed, but subsequently it was found that in many cases a positive test could be obtained prior to the onset of the cytopathic effect.

The specific nature of this phenomenon is indicated by the following facts. (i) Although several batches of monkey kidney cell cultures of various ages and stages of nonspecific degeneration were tested, a positive test was never observed in the absence of hemagglutinating viruses. (ii) Cytopathogenic strains of influenza A virus, originally isolated in tissue culture or in eggs and identified by the conventional hemagglutination and hemagglutination inhibition techniques, never failed to give a positive adsorption-hemagglutination test. (iii) Finally, the adsorption-hemagglutination reaction can be completely inhibited by the addition of specific immune rooster serum known to inhibit hemagglutination by the same virus isolate, but not by antiserum prepared against other types of influenza or certain unrelated viruses, such as Coxsackie A and B, ECHO, and polioviruses. Incomplete studies suggest that the reaction is inhibited only by serums against closely related type A strains.

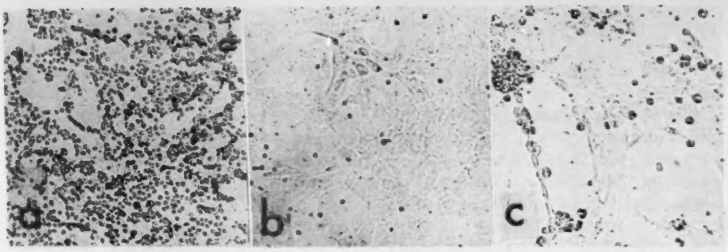

Fig. 1 (*a*) Positive adsorption-hemagglutination test with guinea pig erythrocytes in monkey kidney cell culture 4 days after inoculation with influenza A virus (×90). (*b*) Similarly treated normal monkey kidney cell culture (×90). (*c*) Typical influenza virus effect in monkey kidney cell culture of the same age, prior to addition of erythrocytes (×90).

This adsorption-hemagglutination test may be a useful procedure in rapid diagnosis of suspected cases of influenza. The use of this test is particularly attractive because it depends on direct visualization. We have observed positive adsorption-hemagglutination tests in monkey kidney cultures inoculated with seven strains of influenza A. Two recent isolates, A/Md/503/57 and A/DC/1195/57, gave positive tests 3 to 5 days after direct inoculation with 0.2 ml of throat swab suspensions. An egg-isolated strain of Far Eastern influenza A virus (A/Jap/305/57) was positive after each of the four passages in monkey kidney tissue culture, and another Far Eastern strain (A/Formosa/313/57) was positive upon passage of the egg material in tissue culture (*4*).

The adsorption-hemagglutination reaction with other hemagglutinating viruses is now being studied in tissue culture systems.

Note added in proof: Since submission of this manuscript, we were able, possibly because of an important change in the technique of the test, to isolate several virus strains from cases of suspected Far Eastern influenza in the United States. Standard monkey kidney cell cultures were changed to Eagle's medium *without any serum,* inoculated with field specimens, and placed in a rotating drum. Twenty-four to 48 hours later guinea pig erythrocytes were added, and the tubes were examined for adsorption-hemagglutination. A homogenized suspension of kidney cells, erythrocytes, and fluid from the positive tubes was inoculated into fresh cultures. This passage was used for identification by inhibition of the reaction with type specific antiserum. Twenty-three specimens from a July 1957 outbreak were tested by this procedure and the conventional embryonated egg technique. Of these, the same eight specimens were found to be positive by both methods. So far, seven of the isolates were shown to be closely related to strain A/Jap/305/57. We were able to detect most of the positive specimens at the time of initial addition of erythrocytes to cell cultures, well in advance of the earliest egg isolation results.

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17 July 1957

Book Reviews

Cytology and Cytogenetics. Carl P. Swanson. Prentice-Hall, Englewood Cliffs, N.J., 1957. 596 pp. Illus. $13.35.

It is difficult to realize that during the 20 years since Darlington's second edition of his *Recent Advances* there has hitherto been only a single attempt to reassess the status of cytogenetics. This was the penetrating, brief critique by H. Bauer, which is incorporated in several scattered chapters of the fourth edition of M. Hartmann's *Allgemeine Biologie* (1953). But the very existence of Bauer's survey is hardly known to English-speaking biologists, and its amalgamation with Hartmann's treatise on general biology has certain disadvantages for the specialist.

The immense productivity of cytogenetical research during the last quarter-century is attested by the fact that *Cytology and Cytogenetics*, by Carl P. Swanson, lists well over 1000 judiciously selected references and that only a very few of these are dated earlier than 1930. Many more could be given, and if the pertinent literature on the fringes of cytogenetics is included as well, the total might well be tripled or quadrupled. We can therefore thoroughly agree with Swanson when he says in his preface that "there is urgent need for a book that asks what has or has not been done," and those of us who have boggled at the task of digesting this wealth of new findings cannot but admire the courage and skill with which he has done it for us—and be thankful.

It should be emphasized at the outset that a consideration of modern cytogenetics definitely constitutes the core of the book. There are lucid, rather brief surveys of the various techniques, of the general features of the cell, and of many aspects of recent developments in the fields of biochemistry and cytochemistry, but care is taken not to diffuse the attack that is made on the central theme. The flowering of cytogenetics, as such, after 1930 had its first incentive in the publications of Belling and Darlington, both of whom recognized the experimental value that is represented in the presence of extra homologs in the cell. But it was Darlington alone who generalized his observations and, leaning heavily on established genetic findings, formulated a set of rules of chromosome behavior which, for the nonce, brought order into the unleavened mass of cytological information that confronted the investigator at that time. All-embracing and logically simple, these rules or generalizations encouraged a very great number of geneticists to add the microscope to their means of analysis, and the sudden increase of publications shows with what renewed zeal they attacked their problems.

The master-key to all of Darlington's generalizations lies in his conclusion that homologous chromosomes attract each other when they are single or "unsplit," but that this attraction ceases or even gives way to repulsion when, in the course of normal events, each chromosome becomes split so as to comprise two chromatids. On this primary generalization also hinges the outstandingly important one that a chiasma that extends between two split homologs must of necessity represent a preceding interchange in which one chromatid of each homolog is involved. This would therefore be cytological evidence that genetic "crossing over" has occurred.

Beginning with Belling, various cytologists have presented arguments that adversely affect the validity of these and others of the generalizations. But although such criticism was often supported by excellent evidence, it has been assiduously ignored by the great majority of cytogeneticists, largely, one presumes, because it could not replace the weakened generalizations with equally usable ones. Swanson now weighs the evidence on both sides of each step of the argument, and there can be no doubt that the balance is against many, if not most, of the long-held rules. Indeed, so imposing is this contrary evidence that even their most confirmed adherent must pause for reconsideration.

Withal, Swanson's conclusions are voiced with commendable reserve and, sometimes, almost regretfully. Thus, when he states (page 212) that the basic rule involving the behavior of single versus split chromosomes "is inconsistent with cytological facts" and that the Darlington hypothesis of crossing over "must be viewed with skepticism" (page 235), he is fully cognizant of the implications of his decisions. He realizes that, although much in Darlington's generalizations may still be profitably employed, the loss of general applicability must inevitably affect their usefulness. In view of the many conclusions that have been and are still being based on them, this is a very serious matter.

Swanson's treatment of the subject clearly points out the future path of the cytologist. It should be remembered that, even at their face value, the generalizations of Darlington rarely go beyond a restatement of his observations on chromosome behavior in the light of genetic findings. Obviously, the cytogeneticist must now step across this threshold and probe more deeply into what determines chromosome behavior. In so doing he would be well advised to join his efforts to those of the chemist and the electron-microscopist. Above all, we must know more about the structure of the chromosome, for, in the final analysis of that structure, a great many—perhaps even most—of the questions posed by Swanson will find their answers. Unfortunately, our progress on this particular path has so far been slow. But when we view the triumphant success that has rewarded such joint efforts in the elucidation of the structure and physiology of the mitochondria—only recently considered to be the prime enigma of cellular structures—there would seem to be little doubt that in this direction lie our best chances for solving this most challenging of our problems.

Swanson has admirably succeeded in his primary purpose of reassessing the status of cytogenetics. In its weakening, or destruction, of long-held ideas, the book may prove disconcerting to the average graduate student, who likes to carry his information in neatly finished packages. But to the student who will soon take his place in the ranks of those who are pushing the front forward, it presents a fascinating vista of possibilities and challenges. And such a student is, after all, the only one who really matters.

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Molecules and Crystals in Organic Chemistry. A. E. Van Arkel. Interscience, New York; Butterworths, London, ed. 2, 1956. 270 pp. Illus. $4.75.

In the first edition (1949) of *Molecules and Crystals in Inorganic Chemistry*, it was stated in the preface that the book "was intended for students in their first year of science or medicine." This statement does not appear in this, the second edition, and therefore the reader must deduce the author's present intent from the contents. This is rather difficult

to do, since the contents of this book are a curious mixture of rather elementary topics, treated in a straightforward way, side by side with quite advanced topics discussed in a very interesting way.

After a brief introduction, we find the following chapters: "The chemical bond," "The ionic bond," "Properties of ionic compounds," "Chemical reactions," "Complex compounds," "Polarization," "Water as a component of compounds and solutions," and "Non-electrostatic bonds." These chapters are full of useful tables of physical properties of numerous compounds. The author has a tendency to attempt to explain almost everything on the basis of purely electrostatic bonds and generally invokes homopolar bonds only where the former approach fails. In the final chapter, on nonelectrostatic bonds, the treatment of covalence is not very deep, when contrasted with the thorough discussions of ionic compounds that are found earlier in the book.

The use of such terms and concepts as *entropy, Madelung constants, free energy, enthalpy,* and *polarizability* and *dipole moment formulas* really makes the book unsuitable for use as a textbook in beginning chemistry courses in this country. On the other hand, the range of topics is not wide enough to justify its use as a textbook in an advanced course. It can be recommended as collateral reading, however, for junior and senior students and as a very good source of review material at the graduate level.

There are, unfortunately, more than the number of typographic errors that one would expect to find in a second edition.

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Biogeography. An ecological perspective. Pierre Dansereau. Ronald, New York, 1957. xiii + 394 pp. Illus. $7.50.

I owe to John Tukey, the mathematician, a distinction which is invaluable in discussing such a book as *Biogeography.* Tukey distinguishes between enterprises at the technologic and those at the scientific level. At the technologic (or engineering) level, work has got to be done, buildings have to be put up, and bridges have to be built, whether the fundamental information is at hand or not. The engineer has to use such facts as are available, make the best estimate he can, and go ahead. The scientist, on the other hand, must get down to the fundamentals of the problem. For a long time to come, any author who, like Dansereau, "embraces the entire field of the sciences of environment," who surveys "the origin, distribution, adaptation and association of plants and animals," must be as much an engineer as a scholar. The facts are fragmentary, the field of inquiry is so vast that information from various disciplines must be drawn together; there is little agreement on basic concepts.

Dansereau's book is one man's attempt to view the entire field, to produce a clear, logical presentation of just how plants and animals are distributed over the face of the earth and an analysis of the forces at work. It is divided into five parallel sections: "History of biota," "Bioclimatology," "Synecology," "Autecology," and "Man's impact on the landscape." Although it makes an ambitious attempt to consider animals as well as plants, it is obviously the work of a botanist. Over three-fourths of the cited works are purely botanical; the remainder are about equally divided between zoology and geography. There is nothing parochial, however, about the author's view of his subject. He has traveled widely and has worked and taught in many parts of the world. Of the five most frequently cited authors, only one, Stanley Cain, is an American. The other four are Europeans, each one from a different country.

The omissions are as remarkable as the vast field which has been so effectively surveyed. The author obviously does most of his thinking about the effects of plants that are big enough to be seen with the naked eye. The notion, developed so effectively at Rothamstead, of the ecological importance of a balance between the various kinds of microorganisms in the soil is nowhere presented. Antibiotics are not mentioned, neither is *Encylia farinosa* or any of the literature that demonstrates the lock-and-key relationship which natural selection may eventually force on species which have been associated with each other over long periods of time. The useful concept of the "ecological niche" does not even make the index, which is otherwise pretty inclusive.

The book is beautifully put together. It is lavishly illustrated; halftones, black and white diagrams, and tabular material make up well over one-third of its content. Ingenious and diverting diagrams illustrate the ways in which different kinds of plants of various aspect make up the vegetable cover of our globe. A 20-page appendix illustrates, in detail, the chief plant communities of the Saint Lawrence valley, as analyzed by the author's methods. There is a subject index, an author index, and an 18-page glossary, with clear definitions of the technical terms (some of them pretty fancy) which stud the text. *Tropophytia,* for instance, the "harmonious control of the habitat by a climate inducing alternation of leafing-out and leaf-fall" gets mentioned in at least eight places, and our old friend "short day" becomes "brevidiurn."

Dansereau's book grew out of courses given by him at São Paulo, the University of Michigan, and the University of Montreal. Its clarity, precision, and logical arrangement bear witness to his great skill as a teacher. Fortunate, indeed, are those young biologists who have had such a summary as this as a part of their scientific training.

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Modern Science and Human Values. A study in the history of ideas. Everett W. Hall. Van Nostrand, Princeton, N.J., 1956. 483 pp. $8.

Under the impact of the atomic bomb, many scientists today are troubled by the fact that their theoretical and technical achievements are not accompanied by a comparable progress in morality. How the destructive power of modern technology can be checked is undoubtedly a question of vital importance, and in this connection a well-established framework of values may seem to be highly desirable. Unfortunately, modern science is not able to build up such a framework; on the contrary, its startling success is exactly attributable to the sharp distinction between facts and values and to the rigorous exclusion of the latter from scientific theories.

The emergence of value-free natural and social sciences out of the evaluating Aristotelianism of the medieval schoolmen and the development of these sciences up to the present is the topic of Everett Hall's study. In spite of the modesty shown by the author in the preface, his book turns out to be one of the best semipopular expositions of these problems. It is based on a reliable knowledge of the rather complicated subject matter and avoids many of the widespread misinterpretations of the scope and the methods of modern scientific thinking—that is, of the Copernican, Newtonian, and Einsteinean theories. Furthermore, it shows a sound appreciation of European, and especially German, romanticism as the antagonist of the spirit of enlightenment. Dialectical materialism, selling itself under the label of a scientific world-view, is rightly unmasked as an offspring of romantic obscurantism.

But at the end of his book the author finds himself confronted with the embarrassing question mentioned previously. He has a keen awareness of the difficulties connected with these problems and denounces the metaphysical attempts to smuggle in the normative under the guise of descriptive clothes as

a shabby kind of trick. Nevertheless, he hopes that certain cognitive emotions can open the gateway to the realm of objective values, but he admits that he is not very sanguine about the prospects of such an endeavor. The European scholar, familiar with the shortcomings of Meinong and Scheler, is likely to share his skepticism rather than his hopes.

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Analytical Pathology. Treatises in the perspective of biology, chemistry, and physics. Robert C. Mellors, Ed. McGraw-Hill, New York, 1957. 477 pp. Illus. $12.

Contrary to what might be suggested by the title, *Analytical Pathology* is not a procedural manual. Rather, it is a collection of separate monographs by well qualified investigators, each of whom has made notable contributions to his subject. In his preface, Eugene Opie, preaching from what he has practiced long and well, states, "The clinician and the pathologist must in very large part borrow from the physicist, the chemist, and the physiologist the methods that can be hopefully used to solve their problems." It is this approach, championed by Virchow, but forgotten by some of his followers, that the editor has called "analytical pathology." Three of the seven major subjects have been covered by five men who do not hold appointments in pathology, but they are nevertheless students of pathology to the extent to which they are investigators of the mechanisms of disease.

Many other topics might have been chosen, but all that are included are indeed ripe for critical appraisal. This they have received in varying degree. The many-sided approach is well exemplified, as is to be expected, in Robert Mellor's own massive review of cancer. The consideration is of relevant work from ancient, as well as from the most recent, sources. Gofman's chapter on "Arteriosclerosis and hypertension" is largely a discussion of his own study of lipoproteins and the relationship that he considers it to bear on the pathogenesis of arteriosclerosis. "Hypertension" is a gratuity in the title and receives practically no attention. Jones' interesting section on "Inflammatory and vascular disease of the glomerulus" likewise is based largely on a single, although excellent, technique. Both writers are at pains to defend their own concepts and to demolish others. Neither of their chapters has the scope of a general review, but each possesses the merit of an extensive personal exploration of difficult terrain.

Ratnoff's contribution on hepatic failure is a consideration of the disturbed chemistry and physiology of cholemia, ascites, and hemorrhagic phenomena. This chapter is notable not only for its wide and judicious coverage but also for its excellent literary style.

Agnes Burt Russfield's summary of the "Adenohypophysis" is as outstanding for today as was Severinghaus' article in *Physiological Reviews* of 1937. There are doubtless some who would disagree with some details of her presentation—for example, with the statement that "castration cells" do not exist in man.

Mueller and Vilter have contributed a valuable survey of the macrocytic anemias, and their associate, Will, an equally timely consideration of abnormal hemoglobins. Wagner's account of hypersensitivity is directed specifically to the role of the connective tissue. The knowledge of the chemistry of this tissue is well summarized. Many will take exception to this writer's statement that the cellular production of antibodies is intimately associated with the lymphoid elements. His use of the term *lupus erythematosus "disseminata"* leaves something to be desired on grammatical grounds. There is a critical summary of recent important work, including Wagner's, on the nature of "fibrinoid."

However one might view the title, this volume will serve to inform and to stimulate all workers in the biological and allied sciences as applied to man.

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Route-Mapping and Position-Locating in Unexplored Regions. Wilhelm Filchner, Erich Przybyllok, and Toni Hagen. Academic Press, New York; Birkhäuser, Basel, Switzerland, 1957. 288 pp. Illus. $9.

Exploration by camel caravan in Tibet and western China is the primary subject of this book. The title may mislead some, since in the United States the term *route-surveying* means surveys of proposed routes of communication (highways, railroads, pipelines, power lines), whereas Filchner uses the term in its European sense of reconnaissance surveys made along the traveler's route. Filchner's references to route-planning are strictly a matter of the planning of *his* route.

It is important to realize that, although the total number of persons who have ever engaged in route-mapping is small, yet such surveys underlie the maps of most of the land area of the globe, including most of Canada, Central and South America, Siberia, central Asia, central Australia, and much of Africa. Anyone who wishes to use maps at any scale larger than a school atlas is immediately confronted with the question of their reliability. This in turn is a very complex question, answerable only in terms of the method used. From this comes the significance of the present work.

The book is in three unequal parts, bound together, consecutively paged, but with separate numbering for the chapters in each part. The first, longest (166 pages), and most important is by Filchner, one of the two or three most important explorers of central Asia. Filchner conducted four expeditions to central Asia between 1900 and 1941, and one to Antarctica. The second section, by Przybyllok (80 pages), covers the standard methods of spherical astronomy and the use of the theodolite. The third section (30 pages), by Hagen, is concerned with the application of photogrammetric methods to aerial reconnaissance surveys. It also follows more or less conventional lines; it is interesting as showing that the techniques of route-surveying are probably no longer needed, since most of the purposes can be met by photomosaics, controlled and uncontrolled.

Filchner's section, which is the meat of the book, emphasizes strongly the most important part of all ground surveys—namely, the problems of staying alive and moving about, of pack animals, food, tents, clothing, and relations with the natives as well as the techniques of field surveying. Few books of travel give as close and intimate a picture of the caravan, its animals roped nose to tail with woolen ropes, packs fastened to boards with holes cut for the humps, a layer of felt under the pack to prevent chafing, leather guards on the feet of some of the camels to prevent scuffing, a leader who must walk, not ride, and even the procedure for collecting camel's dung for fuel.

Filchner's mapping procedures contain some surprises for those accustomed to topographic surveys. The emphasis is on the compass and the watch as the fundamental tools—the compass for direction and the watch, in combination with estimates of speed, for distance. It should be pointed out, of course, that Filchner makes every effort to correct the survey so obtained by frequent astronomical fixes, and by taking bearings as often as possible to mountain peaks; but the backbone of the survey is still compass and watch.

A second important point is that the end-result of the survey is a logbook rather than a plane-table sheet. In the logbook are recorded all times and directions, sketches, and small sketch maps. The final map must therefore be built up from the logbook. Obviously, this means that in the final map there will

be an enormous difference in accuracy between points along the route and points even a mile or so off it, not to mention points 10 or 20 miles away. This fact must be constantly kept in mind by the compiler as he struggles to reconcile various surveys into a map.

The problems of chronometric longitudes are not much discussed in this book, which takes the point of view of the 1930's, when radio time signals became available. In some ways, this is unfortunate, since the most serious errors in the older surveys are often those in longitude, owing to the lack of accurate time.

The style of the book is lively, though marred by occasional Teutonisms. A theoretical example of carrying a survey across a wide expanse of marshy country suddenly develops into a galloping narrative as the reeds catch fire, the camels panic, and the whole caravan stampedes. The problem is intended to illustrate, and does illustrate, the extremely uneven nature of the problem and the resourcefulness required.

This book is recommended for those who must either make or use maps of areas where there is no topographic survey, and especially for those whose interest is in central Asia.

JOHN A. O'KEEFE
Army Map Service

Optics. The science of vision. Vasco Ronchi. Translated from the Italian and revised by Edward Rosen. New York University Press, New York, 1957. 360 pp. Illus. $10.

Vasco Ronchi, well-known among astronomers, amateur telescope makers, and those who must test optical devices for his grating test, announced in 1925, is director of the National Institute of Optics in Arcetri, Italy, a suburb of Florence. Much excellent optical research has been published from this center of Italian optics, and the workers at the institute enjoy a well-deserved reputation for scientific competence.

As the term is universally used today, *optics* embraces all but a very few phenomena associated with radiation, and such a discipline would exist without eyes to see. The term is a convenient carryall when the common characteristics of radiation phenomena are in question.

In this discursive, polemical book Ronchi proposes to limit the term to those aspects in which the eye—and the eye of sentient, sensing man only—is involved. This regressive step is made in all seriousness, and those limited parts of optics in which the eye is involved are carefully, logically, and clearly, though largely nonmathematically, explained and developed from a few principles. Ronchi characterizes the optics which to him constitutes the heart of the subject as "anthropomorphic optics," the same field that was understood until the 17th century to be all of optics.

Ronchi develops this viewpoint with great skill, but he inevitably produces a false impression of the richness of the discipline he is discussing. It is very doubtful that any idea of this fullness can be conveyed without detailed physical, physiological, and psychological explanations. For these there is no room in the book, and no hint that the old saw "the eye receives light, but the mind sees," has a profounder meaning than that exemplified in the "effigies," the mental constructs from sense data defined on page 70, and in the examples Ronchi discusses.

The position adopted by the author leads to some surprising conclusions, of which the most startling is in the following statement, taken from page 288: "The virtual image is purely a mathematical fiction. It may be useful as an intermediate solution in the study of complex optical systems. . . ." This is indeed unsound doctrine, unsupportable by any argument known to me, and refuted every time a man shaves the man in the mirror (virtual man, beard, and razor), or a woman powders the nose of the virtual woman with a virtual puff loaded with virtual powder, or an ametrope puts on his spectacles.

The book is well printed and bound, and the errors that I caught are relatively few in number. The translation is smoothly done, no traces of the original Italian remaining, unless it be in the unusual term *centric,* used for Airy disk, or *effigy,* the mental construct alluded to in a preceding paragraph. Lines 9, 10, 11 on page 231 seem to be an incomplete sentence; the figure illustrating astigmatism, on page 268, is unclear and misleading; and Fig. 20, on page 78, is inverted: the trochlear pulley is actually above the globe of the eye.

It is difficult to identify the intended reading public. As a textbook or a reference work, the book is limited in scope, and the controversial features would mislead the casual reader whose knowledge of physics or optics is an insufficient guide to the good that is in the book. The lack of any bibliographic references whatever makes impossible the verification of questioned statements and seriously impairs the value of the book. Nevertheless, I found it interesting reading.

The book falls into two parts. The first, of six chapters, constitutes approximately three-quarters of the volume and deals with the history of optics, elementary physiology of seeing, and the arguments centering around "anthropomorphic optics." The second part deals with wave motion. This section is notable for the clear physical arguments the author advances for the elementary wave phenomena he discusses. Very little mathematics is required to understand the arguments, though trigonometry and differential calculus are sparingly used.

ALLEN E. MURRAY
Bausch & Lomb Optical Company

Lectures on Rock Magnetism. Being the second Weizmann Memorial lectures, December 1954. P. M. S. Blackett. Weizmann Science Press of Israel, Jerusalem, 1956. 131 pp. Illus. $5.

In this engaging little book, P. M. S. Blackett reviews the present state of knowledge in a new and very active field of research. The abundance of data that is rapidly accumulating on the intensity and direction of the natural "permanent" magnetization of geologically dated rocks has shown that rock magnetism may become a powerful tool to trace the history of the earth's magnetic field and of the movement of land masses over its surface. Although he is one of the chief investigators in this field, Blackett has maintained an admirable objectivity in discussing the various controversial hypotheses that are being so avidly championed. The three chapters of the book—the general discussion of rock magnetism and its application, the description of the experimental work, and the synthesis of the recent results—are succinct and lucid expositions which are sufficiently complete to introduce any technical reader to rock magnetism and are "meaty" enough to be of interest to those already acquainted with it.

The first chapter is a review of the historical development of the subject and includes straightforward descriptions of how rocks acquire their magnetism, of the various mechanisms by which this magnetism can be reversed by physical-chemical changes, and of the observed reversals in rocks and their possible significance in terms of reversal of the earth's magnetic field.

The second chapter discusses the various laboratory measurements that can be made on rock and mineral samples and the pitfalls that are inherent in them. Blackett's conclusion is that much can be learned from such laboratory tests, but, because many of the mineralogical and chemical properties of the rocks change in the course of these tests, great care must be taken before the results are applied to natural phenomena.

The first part of the third chapter is a synthesis of the results of measurements of rock magnetism, throughout

the world, which relate to the movement of the magnetic pole and to the relative movements of land masses over the surface of the globe. Blackett's conclusion is that, although much work is needed, preliminary results indicate that there is no doubt that polar wandering and continental drift have both occurred in geologic times.

In the second part of this chapter the various observations of reversed magnetism are discussed, and their possible support of field reversal is considered. It is Blackett's conclusion that at the present time there is not sufficient evidence to support the hypotheses that the earth's field has, or has not, reversed.

The three appendixes to the main part of the book are new contributions and are, therefore, more technical and of interest primarily to workers within the field. With D. J. Sutton, Blackett has developed equipment for vibrating a specimen between identical pickup coils so that measurements can be made of the magnetizations of materials under different conditions of temperature and magnetic field. By measuring the distance that small grains jump to a cubic magnet of known strength, he shows how rough quantitative determination can be made of the remanent magnetization and coercive force of small grains. In the third appendix Blackett presents a new theory, with experimental confirmation to explain the irreversible change with rising temperature of the sign of magnetization of natural materials composed of magnetically hard and soft components.

With this small book Blackett has filled a great need for an objective review of the status of rock magnetism and its application to the study of polar wandering and continental drift. Geologists and others interested in these problems will find his clear and candid discussion a bright spot in the mass of recent publications on this subject.

J. R. BALSLEY

U.S. Geological Survey

Climate and Economic Development in the Tropics. Douglas H. K. Lee. Published for the Council on Foreign Relations. Harper, New York, 1957. 182 pp. $3.50.

This rambling, philosophizing, and poorly integrated little book seems to be more the amassed output of the whole study group of the Council on Foreign Relations than of its stated author, who acted as group *rapporteur*. Although ostensibly a scientific inquiry into its title subject, it is heavily larded throughout with obvious propagandizing for greater American support to underdeveloped tropical countries—the Point Four program of New Deal days. Douglas Lee greatly weakens his own contribution in the fields of animal and human adaptation to tropical climates by first castigating severely Ellsworth Huntington and his works on climatology and then stating, as his own summarized deductions, the very ideas Huntington had so ably presented and supported decades ago!

The book is divided into seven chapters: "Introduction," characterized chiefly by the author's uncertainty about whether to consider as tropical those countries lying within tropical latitudes or only those in the tropical lowlands of moist heat; "Tropical climates," in which his uncertainty persists; "Crop production," "Animal production," "Health and human efficiency," and "Industry," each with subsections on the "Effects of climate," "Circumventing the effects," "Complicating factors," "Required action," and "Preferential regions"; and "Prospect," which more or less summarizes the volume's contents and premises. The book carries no index, and textual references to works listed in the bibliography are at times vague and uncertain, except for those quoted in support of the author's main theses. Various types of data quoted in support of arguments that point up the need for American help to underdeveloped tropical lands are quite without scientific significance as presented.

After all his castigation of Huntington and the latter's "gospel of climatic determinism," Lee's final summations revert directly back to the central core of Huntington's theories on climatic dominance over human achievement: "When acclimatization is complete, there remains an increased disinclination for work which tends to reduce normal output. . . . Some reduction of mental initiative is probably the most important single direct result of tropical environments. Accuracy may be affected in poorly motivated persons, and the need for increased concentration may be felt as a strain."

The volume represents a frank attempt at scientific evaluation of its title subject for the Council on Foreign Relations, with its first major objective: ". . . to state the present position of our knowledge concerning the effects of climate upon tropical development, *so that policy makers, executives and scholars could be reliably informed*" (my italics). It is my considered opinion that Lee's "attempt to bring into focus some of the scattered fragments of information . . . ." fails to provide scientifically reliable evidence in support of his stated objective—"that policy makers, executives and scholars . . . be reliably informed."

CLARENCE A. MILLS

University of Cincinnati

Some Principles of Energetics in Biochemical Reactions. Irving M. Klotz. Academic Press, New York, 1957. vii + 64 pp. Illus. $3.

The object of this small, 60-odd-page book is "to afford a reading knowledge of the language of thermodynamics" for the biologist who is without the mathematical background necessary for a study of the usual textbooks. One should say immediately that Irving Klotz has accomplished this in a very successful fashion.

After a brief introduction, the first two sections of the book are devoted to an exposition of the first and second laws of thermodynamics, with a minimum of mathematical treatment. In the next sections the concept of free energy is developed, and the relation between chemical potential and concentration is illustrated with a number of examples from the biochemical literature. The next section is concerned with the "high energy bond" so much talked of in contemporary biochemical circles. The final two sections are concerned with (i) a thermodynamic treatment of electrochemical reactions, osmotic pressure, and the ultracentrifugal measurement of particle weights and (ii) a brief consideration of some of the basic concepts of statistical thermodynamics.

The language is clear, the examples are apt, and the argument is logical. The book is recommended to the biologist who is without mathematics and to the medical student; it will serve as an admirable introduction to a more rigorous mathematical treatment of the subject.

E. A. EVANS, JR.

University of Chicago

New Books

Economic Development. Theory, history, policy. Gerald M. Meier and Robert E. Baldwin. Wiley, New York; Chapman & Hall, London, 1957. 607 pp.

International Astronomical Union, Transactions, vol. IX. Ninth general assembly, Dublin, 29 Aug.–5 Sept. 1955. P. Th. Oosterhoff, Ed. Cambridge University Press, New York, 1957. 802 pp. $15.

An Introduction to Automatic Digital Computers. R. K. Livesley. Cambridge University Press, Cambridge, England, 1957. 61 pp. $1.75.

H. A. Lorentz, Impressions of His Life and Work. G. L. De Hass-Lorentz, Ed. North-Holland, Amsterdam, 1957. 172 pp. $3.

Microwave Measurements. Edward L. Ginzton. McGraw-Hill, New York, 1957. 532 pp. $12.

Studies on Hysteria. Josef Breuer and Sigmund Freud. Translated from the German and edited by James Strachey in collaboration with Anna Freud. Basic Books, New York, 1957. 366 pp. $5.50.

Meetings and Societies

Radiation Research

The fifth annual meeting of the Radiation Research Society was held at the Hotel Sheraton in Rochester, New York, 13–15 May 1957. It was arranged by a committee headed by H. A. Blair (University of Rochester). The number of registrants was 312.

The program was arranged by a committee headed by Howard J. Curtis, (Brookhaven National Laboratory). There was one symposium on "Radiation chemistry," one on "Radiation genetics," and one on "General radiobiology." These were attended by all members of the meetings. The other sessions consisted of 148 short papers on radiation biology, chemistry, and physics.

Charlotte Auerbach (University of Edinburgh), the principal invited lecturer, discussed "The action of mutagenic chemicals." Henry S. Kaplan (Stanford University School of Medicine) delivered the presidential address at the annual banquet, on "Radiation research and the future of radiotherapy."

New officers were elected as follows: Howard J. Curtis, president; Milton Burton (University of Notre Dame), vice-president and president-elect; E. L. Powers (Argonne National Laboratory), secretary-treasurer.

In cooperation with the National Academy of Sciences–National Research Council, the Radiation Research Society is sponsoring the International Congress of Radiation Research at Burlington, Vermont, 10–16 Aug. 1958. Its sixth annual meeting will be held at that time.

The society has demonstrated steady growth during its brief life. There are now 657 members, including 57 who were elected to membership at the Rochester meeting. The journal *Radiation Research*, sponsored by the society and published by Academic Press, Inc., is now publishing its sixth volume. There are two volumes a year.

Information concerning the society may be obtained from E. L. Powers, Secretary-Treasurer, Radiation Research Society, Argonne National Laboratory, Box 299, Lemont, Illinois.

E. L. Powers
Argonne National Laboratory, Lemont, Illinois

Physics Teachers

The American Association of Physics Teachers met in Schenectady, N.Y., 20–22 June, as guests of Union College and of the Research Laboratory of the General Electric Company.

The first morning session, held at the Research Laboratory, comprised a G.E. film on crystal growth and several short papers on specific problems of teaching. Leo Nedelsky of Chicago, in his invited paper on "Measuring our successes," spoke on the philosophy and implementation of tests and examinations. He suggested three noncorrelative types of testing questions: (i) those dealing with questions discussed in the textbook and classroom, (ii) those showing ability to apply the methods of science to cases not considered before, and (iii) those showing the ability to read and analyze. After a welcome from C. G. Suits, director of General Electric research, the afternoon session included three excellent invited papers by members of the G.E. staff: on ferromagnetism by C. P. Bean, on crystal dislocations by F. C. Fisher, and on semiconductors by A. G. Tweet.

The second day's meetings were held at Union College. Two of the high-school films by Harvey White were shown; the photography and speech reproduction were excellent, but the college teacher was sometimes surprised at the details omitted in this presentation intended for secondary schools. President Davidson of Union College welcomed the group by sketching the history of the college from its founding in 1795 in terms of the American Revolution, the French Revolution, and the scientific industrial revolution of the early 19th century (when Nott was president not only of Union, but, for a few years, of the Rensselaer Polytechnic Institute, 15 miles distant) to the present "educational revolution," in which both the amount of knowledge and the number of students are increasing "explosively."

Harold P. Knauss of the University of Connecticut reported on the Conference on Laboratory Instruction in General Physics, held a few days previously at Storrs, Conn. The problem is to make the elementary laboratory more stimulating. It was urged that the laboratory work be "free" rather than conventional, in particular that the work be arranged in such a way that the students do not lose the pleasure of determining something unknown and that, under subtle guidance, new laboratory procedures be initiated and evaluated. There should be reports in the form of a laboratory diary, which should be carefully graded, and there should be a performance examination at the end of the course. This subject of the best method of directing laboratory work is provoking much discussion and thought among physics teachers at present.

Following this, Jerrold R. Zacharias reported on the Physical Science Study Committee, which is trying to improve the teaching of physics in the high schools. For this, a set of films is being developed at Massachusetts Institute of Technology, and demonstrations are being planned which can be built by students or teachers for less than $10. The present status of "parity" was discussed by C. D. Swartz, of Union, in the afternoon.

At the banquet at the Research Laboratory, Irving Langmuir spoke on "Motivations for science careers," basing his points largely on autobiographic data.

At the final session, D. S. Ainslie of Toronto, in showing several striking experiments in electrostatics, noted the superior qualities of polystyrene and lucite over wax and glass in getting charges, even in damp weather. R. J. Seeger raised a good many points in his provocative discussion "On teaching thermophysics." William McKinley spoke on the complex subject of the "Search for a fundamental length in physics" for atomic quantities.

Mildred Allen
Mount Holyoke College, South Hadley, Massachusetts

British Association for the Advancement of Science

The 119th annual meeting of the British Association for the Advancement of Science will be held in Dublin, 4–11 Sept. Previous meetings of the association in Dublin were held in 1835, 1878, and 1908. The president this year is P. M. S. Blackett, and he has chosen the title "Technology and world advancement" for his presidential address, which will be delivered in the library of the Royal Dublin Society on the evening of 4 Sept.

T. S. Wheeler, head of the department of chemistry, University College, Dublin, is chairman, and G. F. Mitchell, registrar of Trinity College, Dublin, is vice chairman of the Local Organising Committee.

The scientific program this year will

have an agricultural slant, which it is hoped will prove of particular interest in Ireland. The president of the Agricultural Section is Sir James Turner, president of the National Farmers' Union and an outstanding public figure in the agricultural world. There will be a major exhibition of agricultural equipment and methods in the Great Hall of University College, Dublin. There will also be a number of papers on specifically Irish topics.

In addition, two special evening lectures will be delivered in the library of the Royal Dublin Society: the first will be given on 5 Sept. by S. P. O'Riordain, a distinguished Irish archeologist, on the subject of "Tara." The second will be given on 6 Sept. by H. J. Bhabha, secretary to the Government of India Department of Atomic Research and director of the Tata Institute of Fundamental Research in Bombay.

Fluid Flow through Porous Media

Fluid Flow through Porous Media is the subject of a conference to be held 23–24 Sept. on the Norman campus of the University of Oklahoma under the sponsorship of the School of Petroleum Engineering. The purpose of the conference is to bring together a small group of specialists interested in discussing theories of single and multiphase porous media flow. In addition to prepared papers, free discussion will be emphasized. There will be no preprints, reprints, or other publication of papers or discussions.

P. C. Carman of Pretoria, South Africa, will be the guest of honor and featured speaker. He is chief research officer of the National Chemical Research Laboratory, South African Council for Scientific and Industrial Research. Carman is best known for his modifications of the Kozeny equation and his recent book, *Flow of Gases through Porous Media.*

World Aeronautical Sciences

The International Council of the Aeronautical Sciences was formed on 30 May, when 16 representatives of 10 nations met in Paris as a provisional council. The Institute of the Aeronautical Sciences, with headquarters in New York, will act as the permanent secretariat of the ICAS and provide the operating staff. The first international congress of the new organization is scheduled for September 1958 in Madrid, Spain. Subsequent congresses will take place in other countries biennially.

Funds toward support of the ICAS are being made available through the institute from a substantial donation by Harry Guggenheim, an IAS honorary fellow. In his honor, the ICAS has established the Daniel and Florence Guggenheim International Memorial lecture, which will be presented by one of the world's outstanding aeronautical scientists at each international congress. Every country in the world that has any organized society dedicated to the advancement of the aeronautical sciences will be invited to participate in the ICAS without regard to military or political interest.

Theodore von Karman, chairman of the advisory group for aeronautical research and development of NATO, was elected honorary president and permanent member of the council. Maurice Roy, director of the office National d'Etudes et de Recherches Aeronautiques, France, was elected chairman of the provisional council's executive committee. The 16 delegates at the ICAS organization meeting who constitute the provisional council are John J. Green (Canada); G. de Faget, J. Jarry, and Maurice Roy (France); Hermann Blenk (Germany); A. M. Ballantyne and E. T. Jones (England); A. J. von der Maas (the Netherlands); G. Gabrielli (Italy); Antonio Perez-Marin (Spain); Bo K. O. Lundberg (Sweden); R. Greinacher (Switzerland); Hugh L. Dryden, S. Paul Johnston, Theodore von Karman, and Frank L. Wattendorf (United States).

Child Psychology

The 35th anniversary of the Child Guidance Association of Worcester, Mass., will be observed 18–21 Sept. with a public lecture by Anna Freud, director of the Hampstead Child-Therapy Course and Clinic, London, England, and a 2-day symposium on child psychology. Miss Freud, the youngest daughter of the late Sigmund Freud, is making her first visit to the United States since 1950 when she spoke at Clark University. It was there in 1909 that her father gave his only lecture in America and introduced his method of relieving mental disorder by the study of the subconscious emotional life of the patient. Following the symposium, Miss Freud will be the honored guest at a convocation in which Clark University will accept a bronze statue of her father, the gift of the American Psychoanalytic Association.

New York Nuclear Conferences

The American Nuclear Society and the Atomic Industrial Forum have announced that Sir Edwin Plowden, chairman of the United Kingdom Atomic Energy Authority, and Lewis L. Strauss, chairman of the U.S. Atomic Energy Commission, will address an all-conference banquet at the Waldorf-Astoria Hotel in New York on the evening of 29 Oct. Each official will describe his country's program for development of atomic energy for constructive purposes.

The banquet is part of a week-long schedule of atomic activities in New York, which includes concurrent conferences of the forum and the ANS, 28–30 Oct., and the 1957 Trade Fair of the Atomic Industry at the New York Coliseum, 28–31 Oct. Other concurrent activities are as follows: the second annual conference on "Careers in nuclear science and engineering," New York Coliseum, 30 Oct., and the first major, unclassified conference on reactor safety, cosponsored by AIF, ANS, and the U.S. Atomic Energy Commission, at the Coliseum, 31 Oct.

Forthcoming Events

September

23–24. **Fluid Flow in Porous Media, Conf., Norman, Okla. (C. G. Dodd, Petroleum Engineering Dept., Univ. of Oklahoma, Norman.)**

23–25. **American Soc. of Mechanical Engineers, fall, Hartford, Conn. (C. E. Davies, ASME, 29 W 39 St., New York 18.)**

23–27. **International Soc. of Bioclimatology and Biometeorology, Vienna, Austria. (S. W. Tromp, Hofbrouckerlaan 54, Oegstgeest-Leiden, Holland.)**

24–25. **Industrial Electronics Conf., Chicago, Ill. (E. A. Roberts, Union Thermoelectric Corp., 2001 Greenleaf St., Evanston, Ill.)**

25–27. **Mississippi Valley Medical Soc., annual, St. Louis, Mo. (H. Swanberg, 510 Maine St., Quincy, Ill.)**

28–30. **American College of Hospital Administrators, 23rd annual, Atlantic City, N.J. (D. Conley, ACHA, 620 N. Michigan Ave., Chicago 11, Ill.)**

29–5. **World Medical Assoc., Istanbul, Turkey. (L. H. Bauer, 10 Columbus Circle, New York 19.)**

30–2. **American Oil Chemists' Soc., fall, Cincinnati, Ohio. (Miss L. R. Hawkins, AOCS, 35 E. Wacker Dr., Chicago 1, Ill.)**

30–8. **International Council for the Exploration of the Sea, 45th annual, Bergen, Norway. (A. Fridriksson, ICES, Charlottenlund Slot, Charlottenlund, Denmark.)**

October

1–4. **American Roentgen Ray Soc., annual, Washington, D.C. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)**

2–4. **American Soc. of Photogrammetry, semi-annual, St. Louis, Mo. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)**

2–4. **Antibiotics, 5th annual symp., Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Administration, U.S. Dept. of Health, Education, and Welfare, Washington 25.)**

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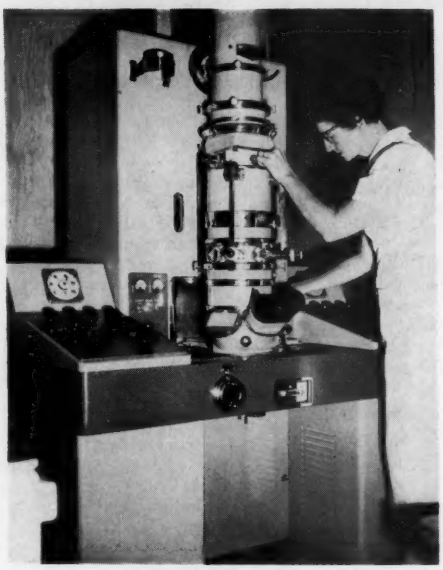

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4. Role of Agriculture in Future Society, 75th anniversary symp., Geneva, N.Y. (New York State Agricultural Experiment Station, Cornell Univ., Geneva.)

4–6. Indiana Geologic Field Conf., 9th, Mitchell, Ind. (H. H. Gray, Indiana Field Conf., Dept. of Conservation, Geological Survey, Bloomington, Ind.)

6–10. Electrochemical Soc., fall, Buffalo, N.Y. (H. B. Linford, 1860 Broadway, New York 23.)

7–9. National Electronics Conf., Chicago, Ill. (J. S. Powers, NEC, 84 E. Randolph St., Chicago 1.)

7–11. American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

7–11. Research Contributions to Clinical Practice, New York Acad. of Medicine Postgraduate Week, New York. (Secretary, Postgraduate Week, New York Acad. of Medicine, 2 E. 103 St., New York 29.)

8–10. International Assoc. of Milk and Food Sanitarians, annual, Louisville, Ky. (H. H. Wilkowske, Dairy Science Dept., Univ. of Florida, Gainesville.)

8–10. Upper Air Conf., American Meteorological Soc., Omaha, Nebr. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

9–11. High Vacuum Technology, 4th annual symp., Boston, Mass. (Committee on Vacuum Techniques, P.O. Box 1282, Boston 9.)

9–11. Society for Experimental Stress Analysis, fall, San Diego, Calif. (W. M. Murray, SESA, P.O. Box 168, Cambridge 39, Mass.)

9–12. Tau Beta Pi Assoc., annual, Madison and Milwaukee, Wis. (R. H. Nagel, Univ. of Tennessee, Knoxville.)

10–11. Noise Abatement Symp., 8th annual, Chicago, Ill. (J. J. Kowal, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

10–13. Angiology, 3rd internatl. cong., Atlantic City, N.J. (H. Haimovici, 105 E. 90 St., New York 28.)

11–13. Iroquois Research, 11th conf., Red House, N.Y. (W. N. Fenton, New York State Museum, Albany 1.)

12. Fat and Diabetes Symposium, New York, N.Y. (T. Kingsley, New York Diabetes Assoc., 104 E. 40 St., New York 16.)

13–18. American Acad. of Ophthalmology and Otolaryngology, annual, Chicago, Ill. (W. L. Benedict, 100 First Avenue Bldg., Rochester, Minn.)

14–16. Association of Official Agricultural Chemists, 71st annual, Washington, D.C. (W. Horwitz, Box 540, Benjamin Franklin Station, Washington 4.)

14–18. American College of Surgeons, 43rd annual clinical cong., Atlantic City, N.J. (ACS, 40 E. Erie St., Chicago 11, Ill.)

14–18. American Soc. of Civil Engineers, New York, N.Y. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

14–18. International Industrial Development Conf., San Francisco, Calif. (E. S. Prentice, Stanford Research Inst., Menlo Park, Calif.)

16–23. Enzyme Chemistry, internatl. symp., Tokyo and Kyoto, Japan. (International Symp. on Enzyme Chemistry, Science Council of Japan, Ueno Park, Tokyo.)

17–18. American Ceramic Soc., 10th Pacific Coast mtg., San Francisco, Calif. (C. E. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio.)

17–18. Industrial Hydraulics, natl. conf., Chicago, Ill. (Conference Secretary, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

17–19. Indiana Acad. of Science, Greencastle. (H. Crull, Dept. of Mathematics, Butler Univ., Indianapolis 7, Ind.)

17–19. Optical Soc. of America, Columbus, Ohio. (S. S. Ballard, Visibility Lab., Scripps Institution of Oceanography, San Diego 52, Calif.)

18–19. National Soc. of Professional Engineers, Bismark, N.D. (P. H. Robbins, 2029 K St., NW, Washington 6.)

19–26. Social Work, 3rd Pan American cong., San Juan, Puerto Rico. (A. Porrata Dorla, Apartado 3271, San Juan.)

20–22. American College of Apothecaries, St. Louis, Mo. (R. E. Abrams, Hamilton Court, Chestnut and 39 St., Philadelphia, Pa.)

21. Air Pollution Symp., 2nd annual, Philadelphia, Pa. (A. D. Hollingsworth, Franklin Inst., Benjamin Franklin Parkway at 20th, Philadelphia 3.)

21–25. Medical Aspects of Workmen's Compensation, New York. (Office of Associate Dean, New York Univ. Post-Graduate Medical School, 550 First Ave., New York 16.)

21–26. Ultra High Frequency Circuits and Antennas, internatl. conf., Paris, France. (Congrès Circuits et Antennes Hyperfréquences, Société des Radioélectriciens, 10, Avenue Pierre-Larousse, Malakoff (Seine), France.)

22. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, ASSE, 425 N. Michigan Ave., Chicago 11.)

22–25. American Dietetic Assoc., annual, Miami, Fla. (Miss R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

(See issue of 16 August for comprehensive list)

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Autoradiography: Terminology and Definition

D. L. Joftes and S. Warren [*Science* **124**, 1155 (1956)] recommend the term *radioautography* in preference to *autoradiography* [W. N. Tauxe, A. H. Moser, and G. A. Boyd, *Science* **120**, 149 (1954); G. A. Boyd, *Autoradiography in Biology and Medicine* (Academic Press, New York, 1955)]. Joftes defines this technique, in part, as a method by which an image is obtained in which the image "corresponds to the distribution of a radioisotope *within* an object"; the image is "the result of radiation from the *contained* isotope and does not necessarily correspond to the interior structure."

I am convinced that the prefix *auto* should be used in the prime position (thus, *autoradiography*) for etymological reasons and beg the indulgence of Joftes and Warren in such use in this communication. The primary purpose of this letter is not to comment on semantic and etymological merits of the two terms but rather to point up the need either for new terms for certain techniques that are identical to, or very closely akin to, *autoradiography*, or for revision of the foregoing definition of the technique. The definition attributed to Joftes and Warren limits the autoradiogram to an image corresponding to radioisotope distribution "within" an object. Such a concept does not recognize the broad implications of the technique in physics, metallurgy, chemistry, and geology, beyond the classical histological applications. Where such a definition is accepted, then certain instances of work could not be defined as *autoradiography* although the method seems best identified by this term. Two examples follow:

1) This is a technique in which a surface is selectively covered with a radioactive isotope in very thin film form [L. E. Preuss, *Nucleonics* **12**, No. 8, (1954)], and the intimate detail of that surface is reproduced through latent photographic image production, by the conventional gross apposition technique, in which an appropriate photographic emulsion is used. This may be generally categorized within the technique under discussion except for the fact that the radioisotope is not imbedded *within* the object.

2) This is a system by which a radioisotope is laid down on a uniform substrate to form a pattern not related to the substrate (L. E. Preuss, in a paper presented before the National Vacuum Symposium, Chicago, Ill., 11 Oct. 1956). This pattern is duplicated again by the gross apposition technique on an autoradiographic emulsion. However, this does not fall into the category of Joftes' "radioautography," since the isotope is on a surface and not in an object. To go farther afield for another example, Erik Odeblad [*Acta Radiol.* **43**, 145 (1955)] discusses a method of radioisotope self-photography and terms it "pin-hole autoradiography." Here, the source is *removed* from the emulsion during the latent image production.

Perusal of the foregoing techniques, the classical histological applications, and the host of other modifications of autoradiography, too numerous to mention, discloses two obvious features that are common to them all, throughout. The first essential is a radioisotope in a particular *pattern* or *array*. The second is the *photographic impression* of that pattern by radiation-stimulated latent image production.

The first two examples outlined seem to fill the general conception of autoradiography, yet the radioisotope is not "within the object." Shall these be called "autoradiography," but with modifying terms to give specific meaning, such as "surface detail autoradiography by gross apposition," for the first example? Such a system is pedantic. The logical alternative is to alter Joftes' definition to one which is more inclusive. It becomes apparent, as time goes on, that multitudinous variations will be played on the theme of the original technique by scientists in every realm of investigation. Thus, a general definition which is not restricted by the limitation within one discipline seems logical.

I submit that autoradiography consists of two essentials: (i) The presence of a radioisotope in some significant array (not necessarily within a matrix); and, (ii) the reproduction of this array through photographic latent image production by the attendant radiation.

Therefore, I propose the following as a more general alternative definition: "Autoradiography is that method in which a photographic response precisely reproduces the significant array of a radioisotope. The isotope may or may not exist within or on some supporting structure or substrate, the latent image production being attributable to the isotopic radiation."

Such a general definition will satisfy the conditions for use of the term by the chemist, geologist, physicist, histologist, and other workers. It may be emphasized that autoradiography is not

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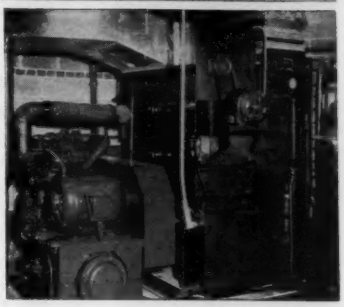

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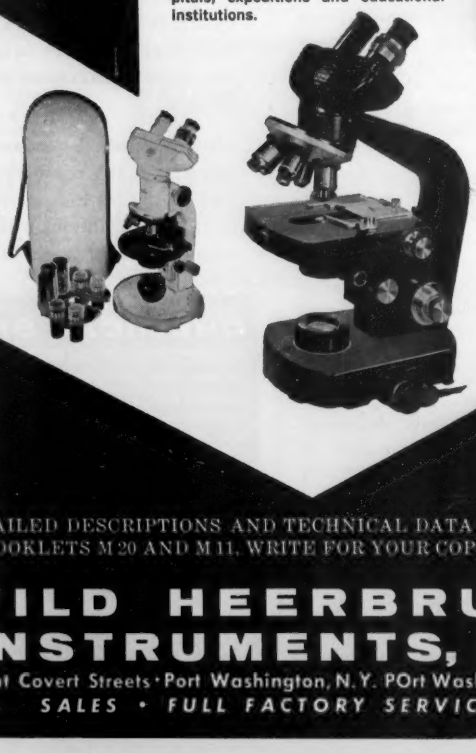

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only applicable to location studies of isotopes in tissues but in the investigation of surface layers as well as self-supporting structures of the isotopes themselves. Thus, the limitation, by definition, that the isotope must be contained within the matrix of some structure is not logical. It is my conviction that this method has now become so common and unrestricted in application to all phases of science that such a definition is contrary to the generally accepted meaning of the term.

LUTHER E. PREUSS
Edsel B. Ford Institute for Medical Research, Detroit, Michigan

Preuss' criticism is based on the erroneous assumption that we were attempting to promulgate the definitive definition of *radioautography*. Actually, ours was simply a working definition, used to describe the basic conditions of radioautography. The fact remains that in all radioautographic techniques, including those of Preuss, there is no external source of radiation which penetrates the object and therefore there is no radiography—auto or otherwise. *Autoradiography* is a self-contradictory term.

As for defining terms, any definition, including that of Preuss, is open to criticism for the reason advanced by Preuss himself—namely, lack of sufficient generality to encompass all the permutations to which the technique is susceptible. For instance, Boyd suggests that the use of photographic emulsions (which Preuss makes a condition of his "general" definition) do not have to be the sole method of registering the image. Other materials that are sensitive to radiation and can be caused to yield a visual image may be used. This kind of hairsplitting is futile and will serve us ill in the long run.

Preuss' definition would be acceptable if it were amended as follows: "Radioautography is a method by which an image is obtained which reproduces the array of a radioisotope or isotopes during exposure of a radiation-sensitive material. The isotope(s) may exist within, on, or near the structure or substrate under investigation, the image obtained being attributable to the radiation emanating from the isotope." Doubtless even this definition is not broad enough.

I hope that my acceptance of all the main elements of his definition will induce a similar attitude of conciliation in Pruess and that he will accept the basic point of the original comment and use the term *radioautography* for the ingenious methods which he has developed.

DAVID L. JOFFES
Cancer Research Institute, Boston, Massachusetts

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ TRANSISTOR CURVE TRACER displays characteristic curves of *p-n-p* and *n-p-n* transistors on the face of a cathode-ray tube. Four to 12 curves per family are traced with input current from 1 μa to 20 ma per step, or with input voltage from 0.01 to 0.2 v per step. Seven different characteristics can be plotted. (Tektronix, Inc., Dept. S501)

■ INTEGRATING DENSITOMETER, for scanning paper electrophoretograms and chromatograms, furnishes two records. One is the curve of optical density, absorbance, or transmittance. The other is the integral of the first curve. The paper strip holder and scanning head will accept a wide variety of paper dimensions. (Matthew Laboratories, Dept. S515)

■ COORDINATE CATHETOMETERS make both a horizontal and a vertical measurement in a vertical plane in one setting. The cathetometer consists of a microscope or telemicroscope mounted so that it can be moved on a vertical bar. This assembly in turn may be moved laterally on horizontal ways. Micrometer screws provide fine adjustments. Coordinate ranges from 2 by 2 in. to 42 by 42 in. are available. (Gaertner Scientific Corp., Dept. S516)

■ METAL DETECTOR has an inspection aperture measuring 64 by 1⅛ in. through which the material to be checked passes. Magnetic or nonmagnetic metals are detected. Sensitivity is adjustable for detection of particles as small as 0.039 in. in diameter. Distortion by metal of the high-frequency electromagnetic field that is set up in the aperture creates an electric signal, which is amplified to trigger an alarm. Strip material can be inspected at speeds of from 10 to 1000 ft/min. (Radio Corporation of America, Dept. S518)

■ CODING DISKS, for shaft-rotation analog-to-digital conversion, are now offered with nonlinear and decimal codes. The disks can be mounted in the manufacturer's standard 6- and 9-in. encoder housings. Decimal code disks up to 100,000 are available. Nonlinear disks can be produced if the original data can be placed on punched cards. Code disks are checked by automatic means to 1 sec of arc. (Baldwin Piano Co., Dept. S564)

■ PULSE GENERATOR operates in the range from 1.6 to 10.4 Mcy/sec. Pulses are half sine wave and are adjustable in amplitude from 1 to 30 v. Five pulse widths are selectable in the range from 30 to 70 mμsec. (Burroughs Corp., Dept. S561)

■ THICKNESS TESTER determines the thickness of plating and other metallic coatings deposited over various metals and nonmetals with accuracy of 90 to 95 percent. A calibration feature permits the instrument to be reset by checking with thickness standards. (Kocour Co., Dept. S558)

■ SLIDE RULE FOR SIGHTLESS individuals employs tactile symbols in the form of raised brads systematically arranged and hammered into a 20-in. Log Log Duplex Decitrig slide rule. The slide rule, which was designed as a gift to a blind student of electrical engineering, yields precision better than 2 to 4 percent. (Keufel and Esser Co., Dept. S562)

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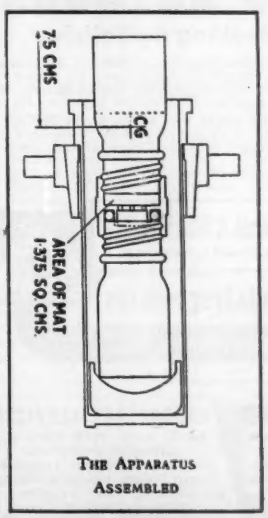

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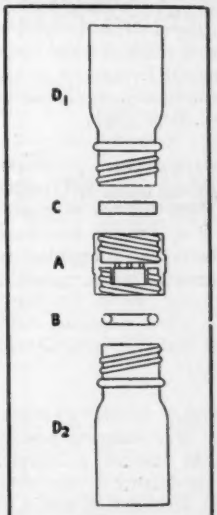

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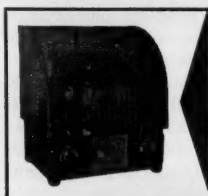
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Director, diagnostic and research tuberculosis laboratory, central Florida, physician or nonphysician microbiologist or clinical chemist. Part-time employment will be considered. Write Dr. Albert V. Hardy, Director, Bureau of Laboratories, State Board of Health, P.O. Box 210, Jacksonville, Florida. uc

Medical Technicians, General (male) for employment with U.S. Government. Under 38 years of age. Must be U.S. citizen. Military experience in medical field desirable. Knowledge of x-ray and laboratory procedures necessary. Willing to serve overseas. Beginning salary $4080 per annum plus allowances. We request that initial reply include professional background and military experience. Box 235, SCIENCE. 8/16, 23, 30; 9/6, 13, 20, 27

MICROBIOLOGIST TISSUE CULTURE. Position available large expanding research and routine laboratory. Experience in tissue-culture methods for research project. Minimal supervision of clinical diagnostic bacteriology. Salary $7000 to $8000 per year. Address Director, Singer Research Laboratory, Allegheny General Hospital, Pittsburgh 12, Pa. Include curriculum vitae. 8/30; 9/6, 13

POSITIONS OPEN

Oceanography—Meteorology. Research assistantships for graduates in chemistry, geology, physics, mathematics, engineering, and biology; $1800 to $3000. Write Department of Oceanography and Meteorology, Texas A. & M. College, College Station, Texas. 8/23

PHYSIOLOGISTS
PHARMACOLOGISTS
BIOCHEMISTS

Ph.D.'s in physiology, pharmacology or biochemistry with major background and experience in field of —

(a) Cardiovascular and/or Nutrition
(b) Endocrinology

. . . for team participation in the development of new therapeutic agents. Large pharmaceutical manufacturer. Philadelphia location. Liberal benefit program. Send résumé.

BOX NUMBER 241, SCIENCE

Research assistant for biochemical-histochemical studies on developmental endocrinology. Good training in chemistry desirable. Salary dependent on qualifications. Write F. Moog, Zoology Dept., Washington Univ., St. Louis 5, Mo. 8/23, 30; 9/6

Research Director is being sought by a Midwest pharmaceutical firm with 200 employees. Applicant must have Ph.D. Duties involve supervision of basic, clinical, and market research. Box 238, SCIENCE. 8/23, 30; 9/6

Research professor in obstetrics and gynecology in college of medicine of large midwestern university. Applicant must have a good background in biochemistry, endocrinology, and physiology. Position available immediately. Salary compatible with experience and ability. Unusual opportunities in research, clinical responsibility, and some teaching. Include bibliography in reply. Box 246, SCIENCE. X

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for September positions in many states and many foreign lands. No fees. Apply direct. Also study awards. Rush $1 for complete job data, salaries. CRUSADE, SCI, Box 99, Station G, Brooklyn 22, N.Y. EW TF

SCIENTIST

Ph.D. in physiology or pharmacology to assist in the evaluation of neuropharmacologic agents for use in mental illness in research activities of Philadelphia pharmaceutical manufacturer. Liberal benefit program. Send detailed résumé.

BOX NUMBER 240, SCIENCE

APPLICATION FOR HOTEL RESERVATIONS

124th AAAS MEETING

Indianapolis, December 26-30, 1957

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in Indianapolis. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Indianapolis and thereby avoid delay and confusion. (Exception: Members of the American Astronomical Society who wish reservations at the Marott Hotel, 2625 North Meridian Street, are asked to correspond directly with that hotel.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less.

As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague. Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 to 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Rates for Rooms with Bath

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 19, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
Antlers	$4.50–10.00	$7.00–12.00	$10.50–12.00	$14.50–19.50
Claypool	7.00–10.00	9.50–14.00	10.50–14.00	13.50–34.00
Continental	8.00–10.00	8.00–12.00	8.00–12.00	12.00–15.00
Marott	7.00–14.50	9.00–14.50	10.00–17.50	14.50 and up
Severin	6.00– 9.00	8.50–12.50	11.00–15.00	25.00
Sheraton-Lincoln	6.50–11.50	9.85–15.00	13.35–16.00	24.35 and up
Warren	6.50–10.50	8.50–12.50	12.00–13.00	25.00–35.00
Washington	5.50–10.00	7.00–11.00	11.50–16.00	18.00–45.00

THIS IS YOUR HOUSING RESERVATION COUPON

AAAS Housing Bureau
1201 Roosevelt Building
Indianapolis 4, Ind.

Date of Application .....

Please reserve the following accommodations for the 124th Meeting of the AAAS in Indianapolis, Dec. 26–30, 1957:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....

.....

First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

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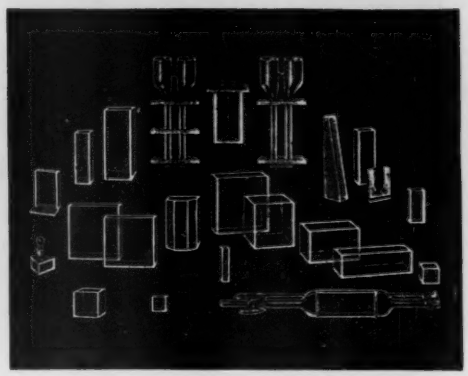

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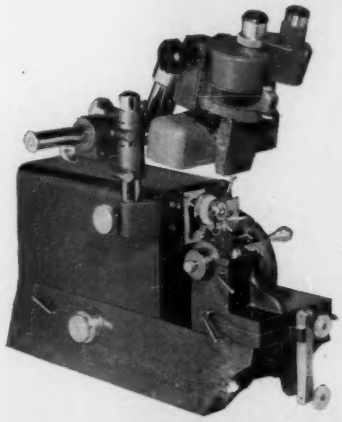

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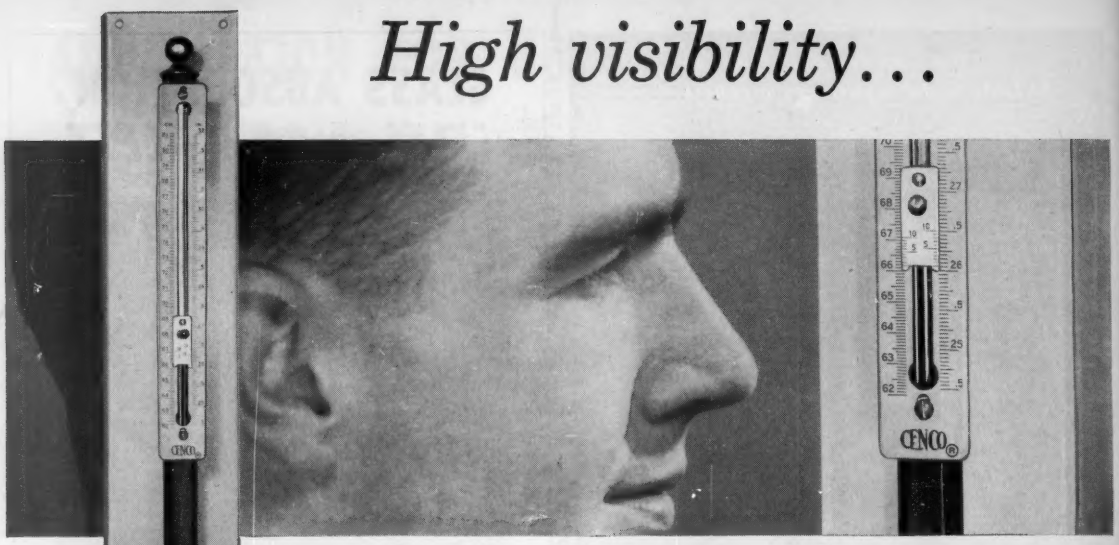

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